Engineering Library

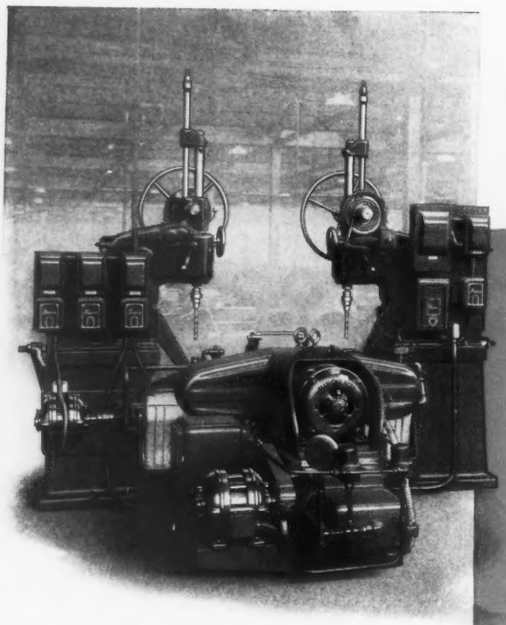
INDUSTRIAL ENGINEERING

MAINTENANCE ENGINEERING
IN PLANTS, MILLS, AND FACTORIES

A McGraw-Hill Publication

AUGUST - 1930

For Cover Story see page 424



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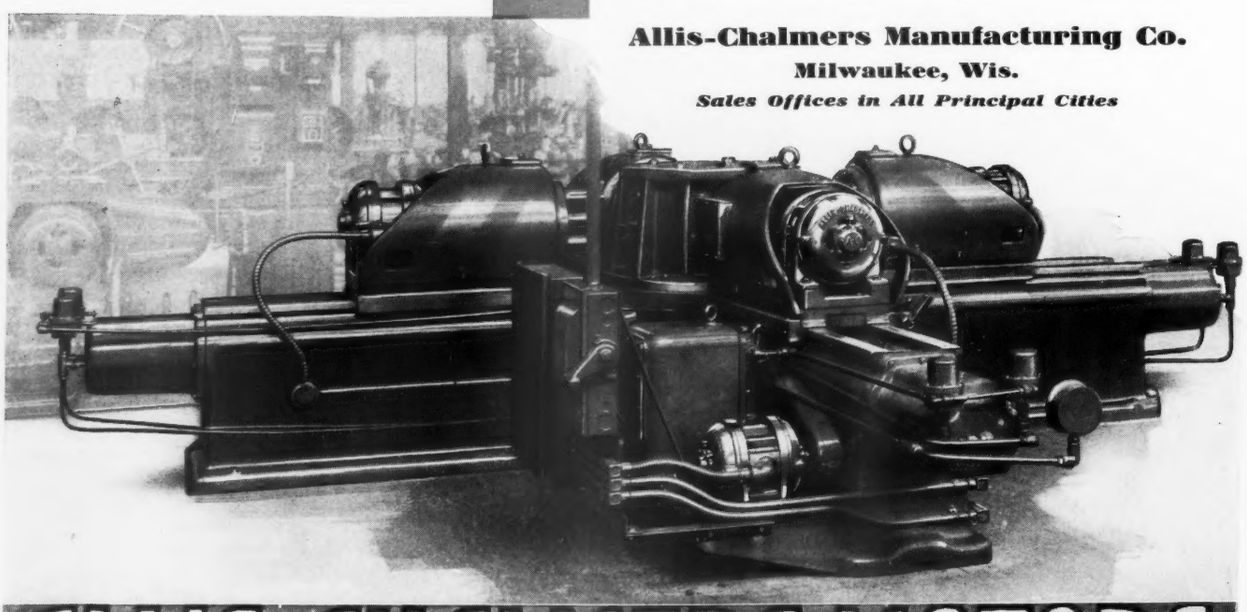

ALLIS-CHALMERS MOTORS

INDUSTRIAL ENGINEERING

Founded in 1882 as Electrical Review. Consolidated with it—Western Electrician and Industry Illustrated.

Maintenance Engineering in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

L. C. MORROW, *Editor*

Volume 88, Number 8

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Every plant has two junk piles, one outside the walls and one inside the walls. The size of the inner junk pile can be kept down by the maintenance men whose primary business it is to keep things from happening. Only slightly less important is their function of recommending modernization, for no one in the organization is in better position to see what is needed and when it is needed to hold obsolescence down to a figure that will insure a reasonably long life for the plant.

From address by R. H. Rogers of the Industrial Engineering Department of the General Electric Company, before the convention of maintenance engineers at Cedar Point, Ohio, during June.

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INDUSTRIAL ENGINEERING

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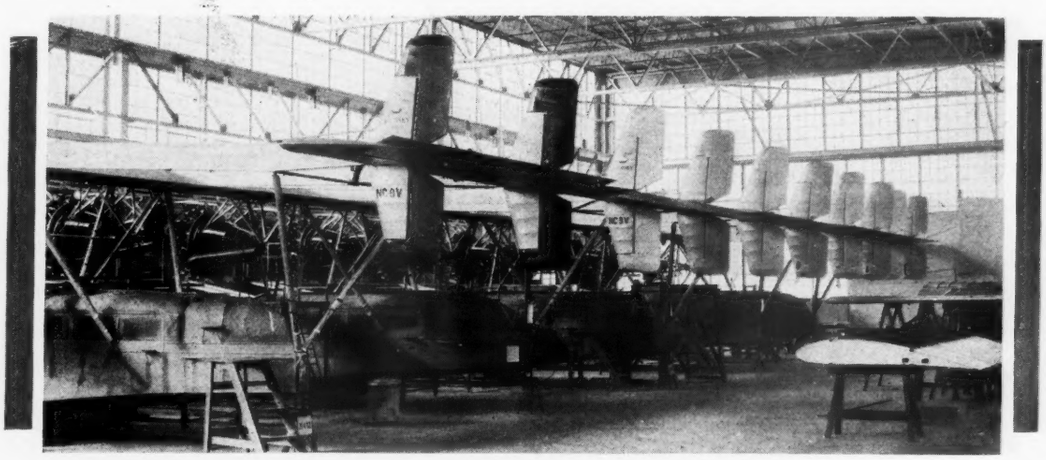


Thoroughly sprinklered assembly bay. An uncurbed fire would destroy products of immense value.

To Prevent Fire Loss—
Don't Have the Fire

Select plant equipment and protection apparatus accordingly. Here's how the Sikorsky airplane factory did just that.

By W. A. COULTER

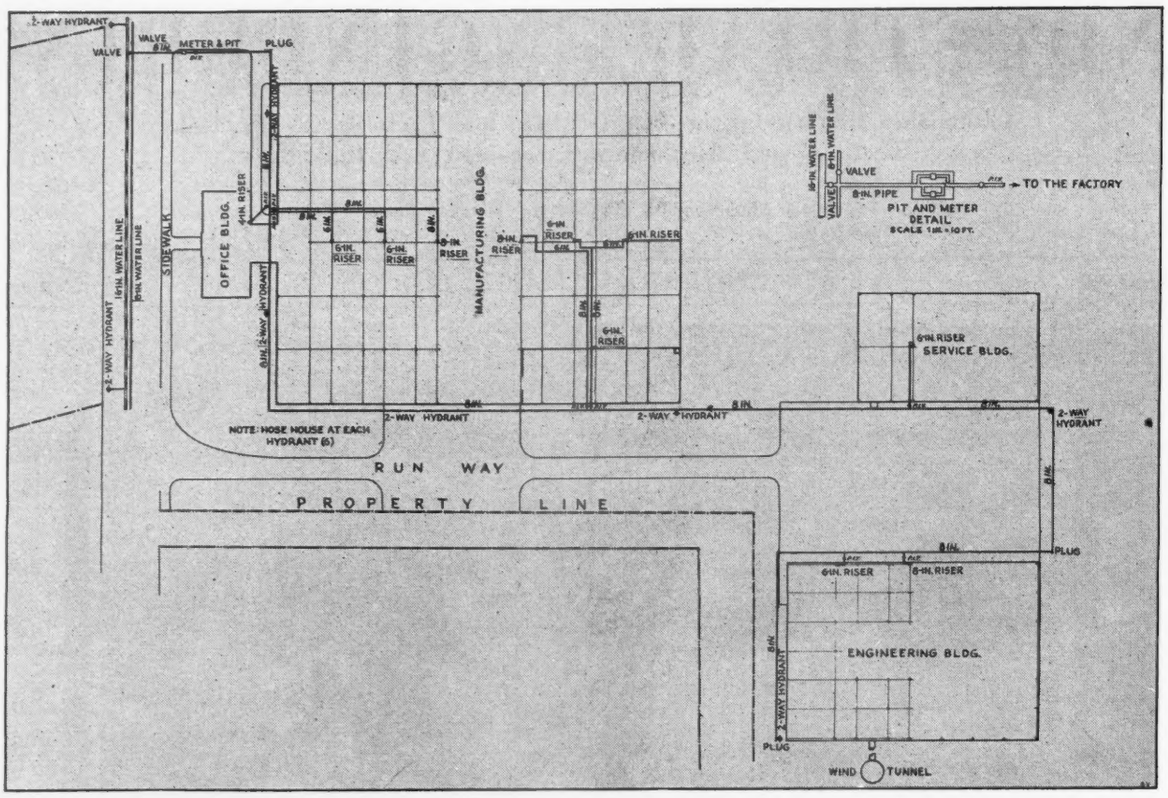
Sikorsky Aviation Corporation
Bridgeport, Conn.

At the Bridgeport, Conn., plant of the Sikorsky Aviation Corporation, adequate fire protection is of utmost importance because the plant is comparatively isolated, the nearest fire station being some two and one-half miles distant in the town of Stratford. Features contributing to risk are the highly flammable nature of some of the materials used in the construction of the planes, processes used in manufacture, and large investment in finished and partly finished planes. In addition there are, of necessity, large areas which cannot be protected by fire walls.

All buildings are of fireproof construction, that is, of structural steel, and brick. About 40 per cent of the wall areas are of glass with steel sash, and the floors are of concrete. The plant consists of one main factory building of 100,000 sq. ft., an engineering and development building of 40,000 sq. ft., and a service building and hangar of 12,000 sq. ft. All of the buildings are one story high with the exception of the office buildings, which are two stories, and are connected to the main manufacturing building and engineering building. The total acreage covered is about ten.

Water is supplied by the Bridgeport Hydraulic Company through an 8-in. and a 16-in. main. The maximum pressure is 75 lb. and minimum 45 lb., with all valves open.

Distribution to the sprinkler system and the locations of the risers are shown by the accompanying dia-



Distribution of water to the sprinkler system, and locations of risers.

Pressure type extinguishers are provided to fight electrical fires.

gram. In the main factory the risers are evenly spaced along the centerline of the building, which is constructed with the monitor system of alternating high and low bays. There are three bays 12 ft. by 20 ft. wide on one side, and three bays 20 ft. high by 30 ft. wide on the other side of the large assembly bay, which is 35 ft. high and 80 ft. wide. The risers at the sides of the high bay are 8 in. in diameter to take care of the large area of this bay and the low bay adjacent to it. All of the other risers are 6 in. in diameter with the exception of the one which serves the system in the assembly bay of the engineering building, an area of 25,000 sq. ft. The sprinkler heads are of usual type and are mounted as close to the ceiling as possible to give maximum head room. In the offices, where sound-absorbing blocks are used on the ceiling, the heads are spaced so as to be located at the joints. The heads are made to let go at 160 deg. F., except at locations near ovens or furnaces where the temperatures are generally higher.

There are 40 hand-type fire extinguishers distributed throughout the factory. Most of them are of the 2½-gal. foam-generating type, and are particularly effective for oil or paint fires. The distribution was made fairly uniform but, where conditions seemed to warrant, additional units were placed. For example, in the dope room there are six 2½-gal. and one 5-gal. extinguishers, allowing about 800 sq. ft. of area per extinguisher. In the factory proper the average is one to 3,500 sq. ft. There are some carbon tetrachloride extinguishers also. They are of the 1-gal. pressure type, and because of the fact that the fluid is a non-conductor, are used for fighting electrical fires. They are placed, one near the main switchboard, one at the battery charging station, and others at similarly appropriate places in the department.

The extinguishers and the columns on which they hang are numbered alike so that correct replacement after use can be made. A diagram of their locations is kept. A few spares are kept on hand to take the place of those that have been used or are being refilled. Refilling is taken care of by the Stratford fire department. Particular care is taken at all times to keep all the fire pro-

tection facilities fully effective by provisions for substitution in case of failure, and by providing spares and auxiliary equipment. Should it be necessary to shut off any of the sprinkler system in order to make repairs, or on account of some construction work, the Stratford apparatus is called upon to stand by until the work is finished.

In addition to the hand extinguishers, there are 10 2-in. valves each with hose 50 ft. long connected, making one hose per 10,000 sq. ft. of area.

Outside of the buildings there are six two-way hydrants with hose houses adjacent, each of which contains four 50-ft. lengths of 3-in. hose, with the usual hose house equipment such as hydrant wrench, lantern, crowbar, axe, hose strap, and hook. The hose houses were built as small and compact as possible to avoid interference with the operation of planes. The doors to the houses are kept closed but not locked.

Should a fire break out in any part of the plant the alarm would be sounded by means of a siren operated by a connection at the telephone switchboard or in the employment office.

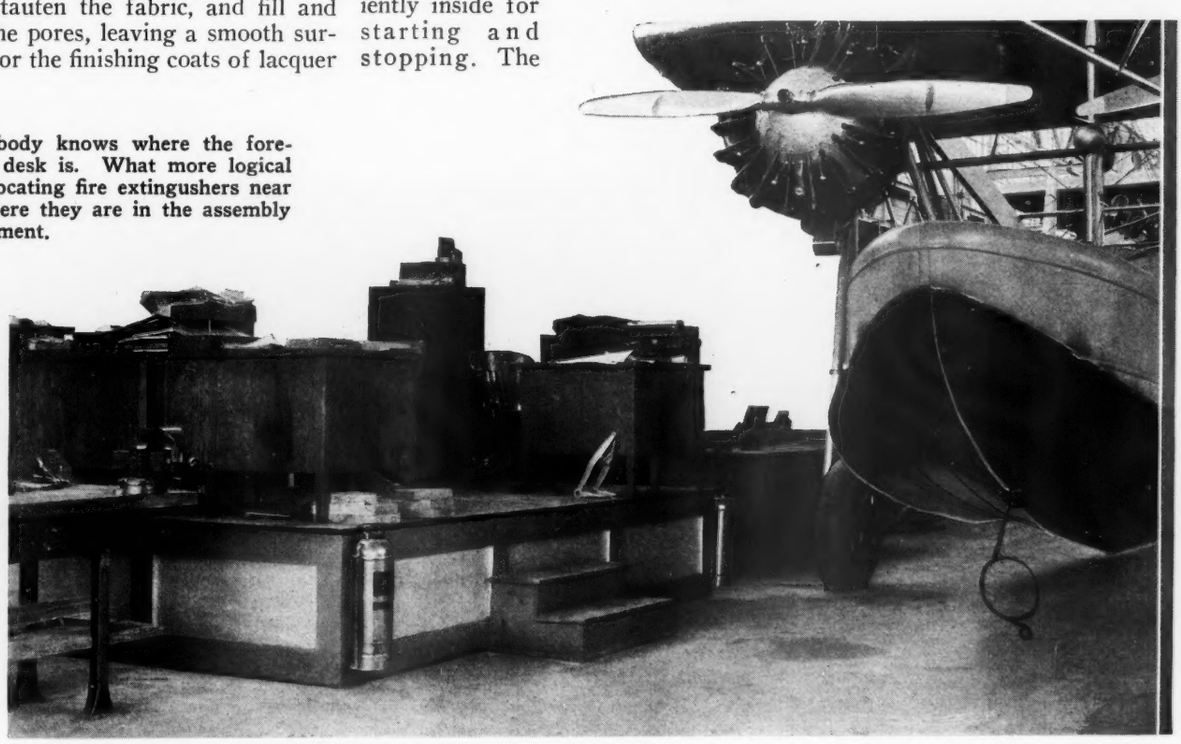
In equipping the factory the thought of fire prevention had to be kept constantly in mind. This was particularly true in regard to the dope room, where the fabric covering on the wings is treated with dope and painted. The function of dope is to tauten the fabric, and fill and seal the pores, leaving a smooth surface for the finishing coats of lacquer enamel, or pigmented dope. Dope is made on a base of cellulose nitrate, which is highly flammable, and extreme precautions have to be taken to prevent its ignition. The dope room is 120 ft. long, 50 ft. wide, and 20 ft. high, and is separated from the remainder of the factory by fire walls and sliding fire doors. Because the fumes of the dope are poisonous and highly explosive, it is absolutely necessary to have adequate ventilation in order to prevent accumulation of the fumes. Our ventilating equipment has the capacity to change the air of the entire room once every two minutes. Under these conditions the mixture of dope fumes and air would not be explosive, but every precaution is taken to prevent a spark from any agency whatsoever. Workmen are required to wear rubber heels, and are prohibited from carrying matches in their clothes. It was found that, due to the static electricity caused by the rubbing or sanding of the panels, a spark would sometimes be caused when another workman approached the one who was rubbing. To prevent even this occurance it was arranged to place the wings on metal stands.

All of the motors which operate the ventilating fans are of the totally inclosed, induction type. They are controlled by magnetic switches located outside of the dope room, but push-button stations of the vapor-proof type are located conveniently inside for starting and stopping. The fans, which are used for conducting away the fumes from the spraying operations, are of the two-blade propeller type, which eliminates the possibility of solid matter in the dope collecting on the blades. Facilities are provided, however, for cleaning.

The general ventilation of the room is taken care of by suction blowers. They are of the multiple-blade type but, because they handle more dilute air, there is not the danger from accumulation of solid matter that is present where the spray guns are being used. As additional safety features, the blowers are located outside of the room on the roof, and are equipped with bronze vanes to minimize the danger of sparking.

Fresh air is supplied to the dope room through unit heaters, located on the outside of the fire wall, and taking the air from the factory. The motors which operate the fans on the heaters are of the approved type, and the openings through the walls can be closed by fire doors on the dope room side. These doors are closed by gravity when the fusible links give way in case of fire. Should a fire occur in the dope room there would be no connection whatever with the factory building. The room is lighted with 500-watt, vapor-proof, one-piece units.

Particular care is taken to keep the dope room clean and everything



Everybody knows where the foreman's desk is. What more logical than locating fire extingushers near it? Here they are in the assembly department.

in order. Strict rules are enforced. There are also rules against performing any other kind of work during doping or painting operations, and bringing in any kind of tool other than the brushes, spray guns, etc., that are used in the regular work.

In purchasing and installing the equipment for the factory, every consideration was given to fire-protective features, and recommendations of the insurance companies were followed closely. Beside the spraying that is done on the wing covering in the dope room, there is considerable painting for the protection and finishing of metal parts, such as the structure of the wings, pontoons, struts, etc. This is done both by spraying and dipping. The principle of having the machine or equipment for doing the work located at the place most convenient for production is followed. For this reason it was impossible to concentrate all painting operations in one place, and, with the units located at various places in the factory, there was considerable detail to be worked out in regard to safety features. The spray booths are of an approved type, all-metal construction, two to four sprinkler heads in each depending upon size. Totally-inclosed motors drive the ventilating fans, and are placed outside of the exhaust ducts. The start and stop stations are of the vapor-proof type, and are located at the booth, but the magnetic switches controlling the motors are placed a reasonable distance away.

There are two ovens for baking the primary coats. They are of the indirect, gas-fired type with forced ventilation, and are thermostatically controlled. These ovens are placed close by the dipping tanks and spray booths; therefore definite and strict regulations are laid down in regard to their maintenance and operation. One oven, which is for the continuous dipping and baking of small parts, is in the same room with the cadmium plating department. The room is sprinklered, and door openings are protected by approved fire doors.

One feature that is interesting in its fire prevention treatment is the arrangement for the storage of paint for the dipping tank. It is advisable to have the paint agitated to prevent the solid matter from settling to the bottom, and it was first planned to have the paint flowing in continuously from the storage tank by gravity feed and returned by means of a centrifugal pump. This scheme was abandoned because of the possibility that in the event of a fire the contents of the storage tank would be discharged into the room, probably with disastrous results. It was decided, instead, to place the storage tank (which is double the capacity of the dip tank) underground, and to vent it to the outside of the building, the vent pipe to be equipped with approved flame arrestor. The discharge from the dip tank to the storage tank is through a trapped drain pipe fitted with a quick-opening valve, which is arranged to open automatically in case of fire. An overflow pipe, of a larger size than the discharge pipe from the circulating pump, and fitted with a trap, leads from the dip tank to the storage tank. The switch controlling the circulating pump is fitted with automatic cutout connected with the quick-opening drain valve. It is planned also to have the dip tank and drain board protected by an automatic foam extinguisher system. All switches and lights in the room are of the vapor-proof type, and a 2½-gal. extinguisher is located just outside the entrance.

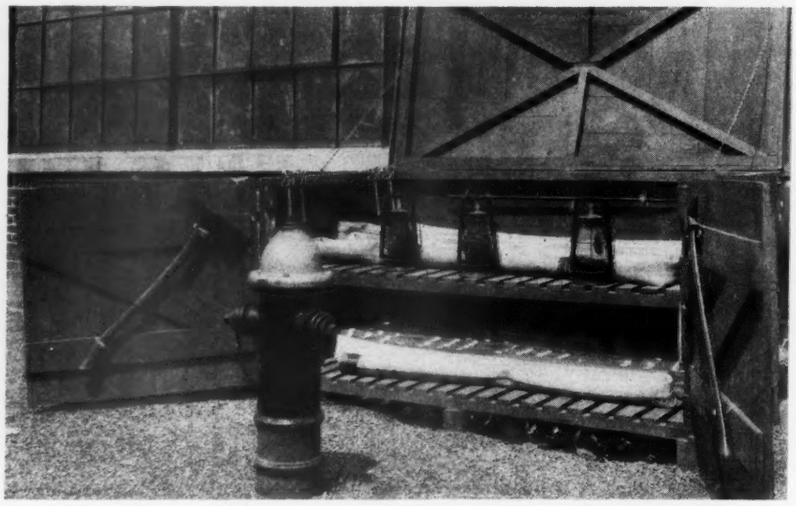
The description just given pertains in particular to the main manufacturing building, but the same scheme has been followed in the other buildings for the arrangement of hose, hand extinguishers, etc. The construction of the buildings is simple, facilitating maintenance and repairs. Electric wiring and piping are the most modern and are cleverly worked out for extreme flexibility. All pipe lines are painted characteristic colors for easy identification. All machines are individually motor driven and the motors are of the non-sparking induction type.

After all, the greatest factor in the prevention of fire at this plant lies, of course, in "good housekeeping." The plant has all of the regulations along this line that are customary at modern manufacturing plants, but there are some, peculiar to airplane manufacturing, that are worth noting.

One important regulation is that no plane be brought into the factory, or any building, with gasoline in its tank. After being emptied, the tanks must be ventilated for a period of two hours to insure the elimination of fumes before any work can be done on the plane. If for some reason it is necessary to start up the engines (the S-38 Amphibian is a twin-engined ship) two hand extinguishers are brought to a position of readiness, one near each engine. The gasoline storage tanks are underground, and the planes are filled from pits which contain the hose and meter, and which, when covered, do not extend above the ground level. It is against the rules to use gasoline in the spray guns for cleaning purposes.

Paint and oil are stored in a fireproof building located more than 50 ft. from any factory building. No paint in bulk is allowed in the factory, except what is needed for immediate use. Any excess must be removed at night. Spray booths, ovens, and ventilating fans must be cleaned regularly to prevent the accumulation of paint and solid matter.

In the service department any welding or process requiring an open flame is prohibited while there are any paint spraying or repair doping operations being carried on.



Hydrant and hose house, with equipment. There are six of them outside of the buildings.

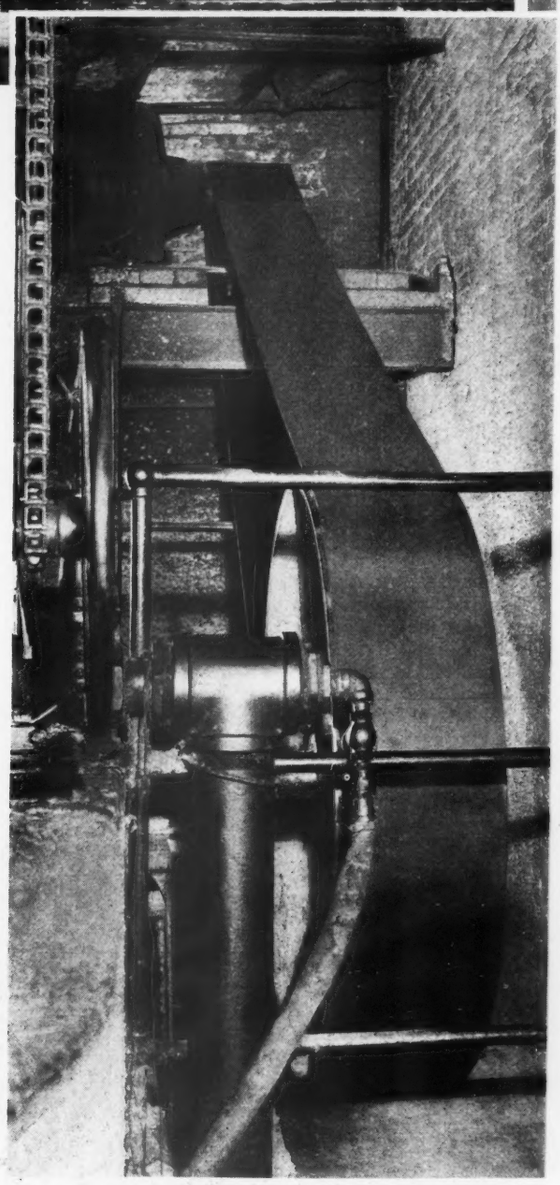
Courtesy Benjamin Electric Manufacturing Company

Acres of light are needed in the modern silk spinning mill. A general view over the frames in the plant of the Sanquoit Silk Manufacturing Company, Scranton, Pennsylvania.

MODERN EQUIPMENT AT WORK

MODERN equipment IS at work. Our July Modernization Issue contained a hundred and forty pictures substantiating this statement.

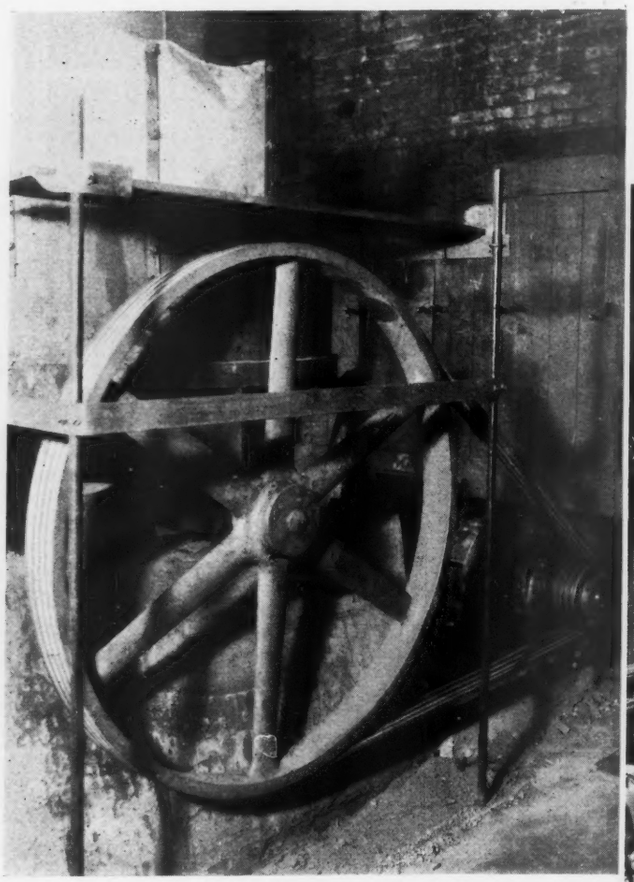
But we want the evidence to be more than enough for the conclusive presentation of the cause of modern equipment. So here is additional picture evidence of modern equipment at work—and there is still more to come next month.



Courtesy Philadelphia Belting Company

Sixteen-inch double belt, with vacuum cups drilled in the face, driving a 50-ton breaker beater of the Carthage Pulp and Board Company, Carthage, N. Y. Motor is 85 hp. at 720 r.p.m., 10-in. pulley. Beater pulley 54-in. Belt length, 38 feet, 6 inches.

MODERN EQUIPMENT AT WORK

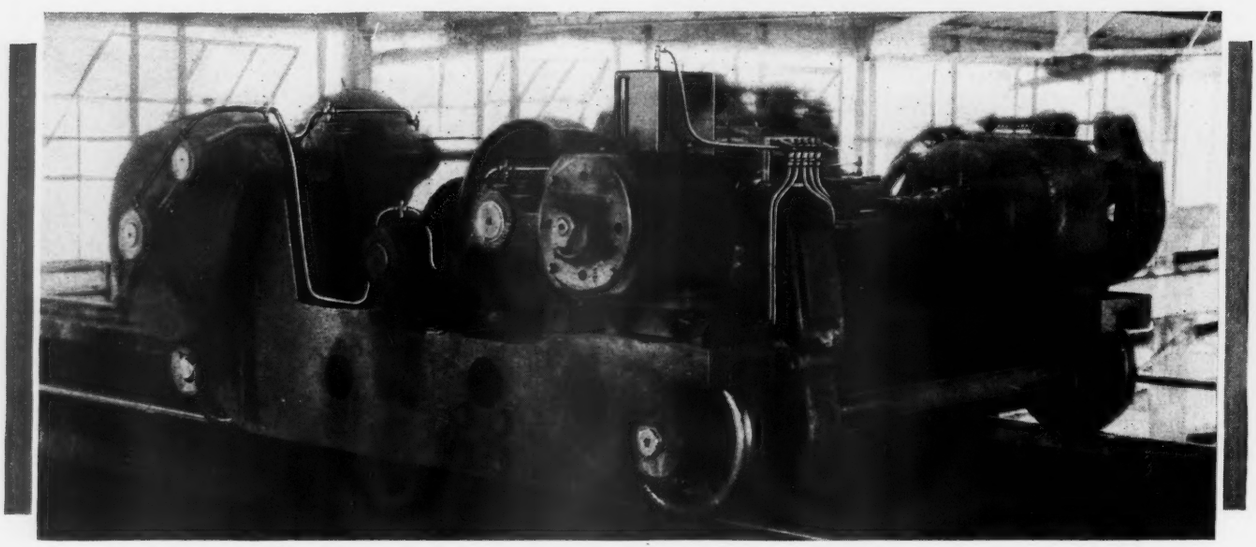


Courtesy Allis-Chalmers Manufacturing Company

Slow-speed motor and multiple V-belt drive operating a foundry sand mixing mill—Zenith Foundry Company, West Allis, Wis. Great reduction, severe service conditions.

Good work depends on the efficient use of good tools. In this motor-car plant imperfect results cannot be blamed on the lighting. It is provided by 300-watt white-bowl lamps in RLM reflectors on 8x10-ft. centers.

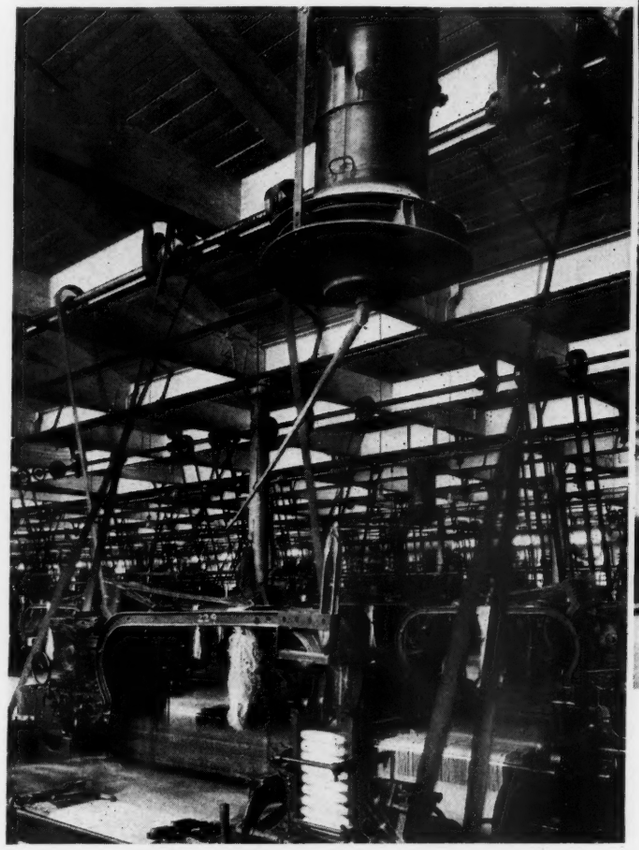
Courtesy National Lamp Works, General Electric Company



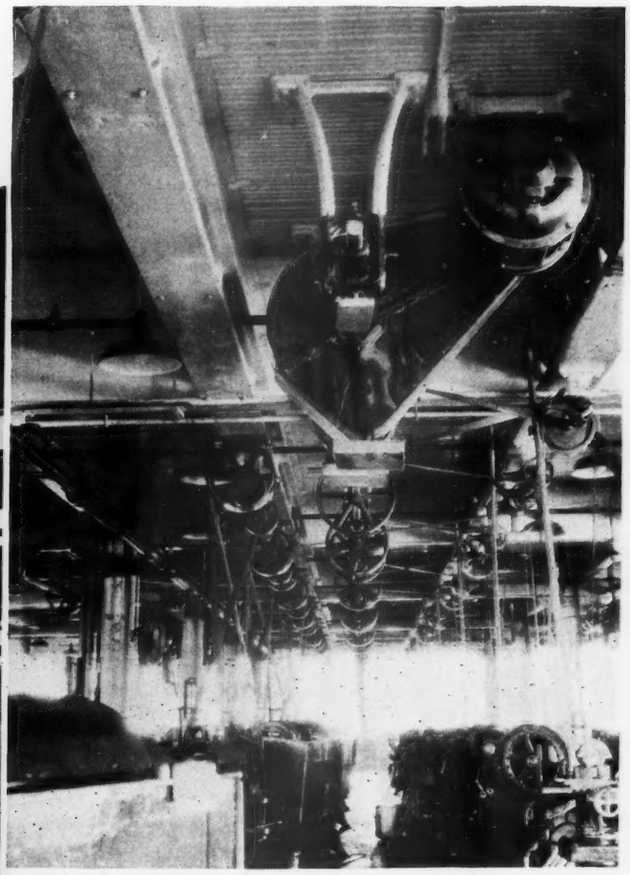
Courtesy Rivett Lathe and Grinder Corporation

Automatic oiling applied to traveling crane. No manipulation by operator. Each feeder is adjusted to deliver the number of drops per hour called for by the bearing it serves—sight feed makes for rapid inspection.

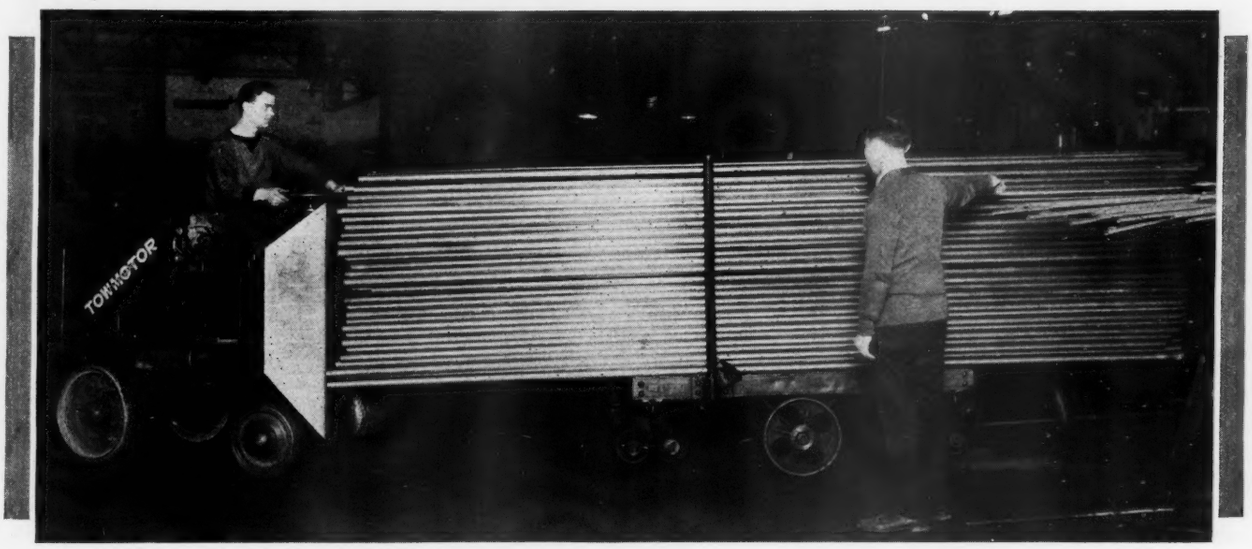
Double ball bearings on line shafting in a weave room of the Pepperton Mills, Jackson, Ga. A test on a similar installation of 78 hanger boxes in another plant showed $409.66 yearly saving, in power, oil, and labor.



Courtesy The Fafnir Bearing Company



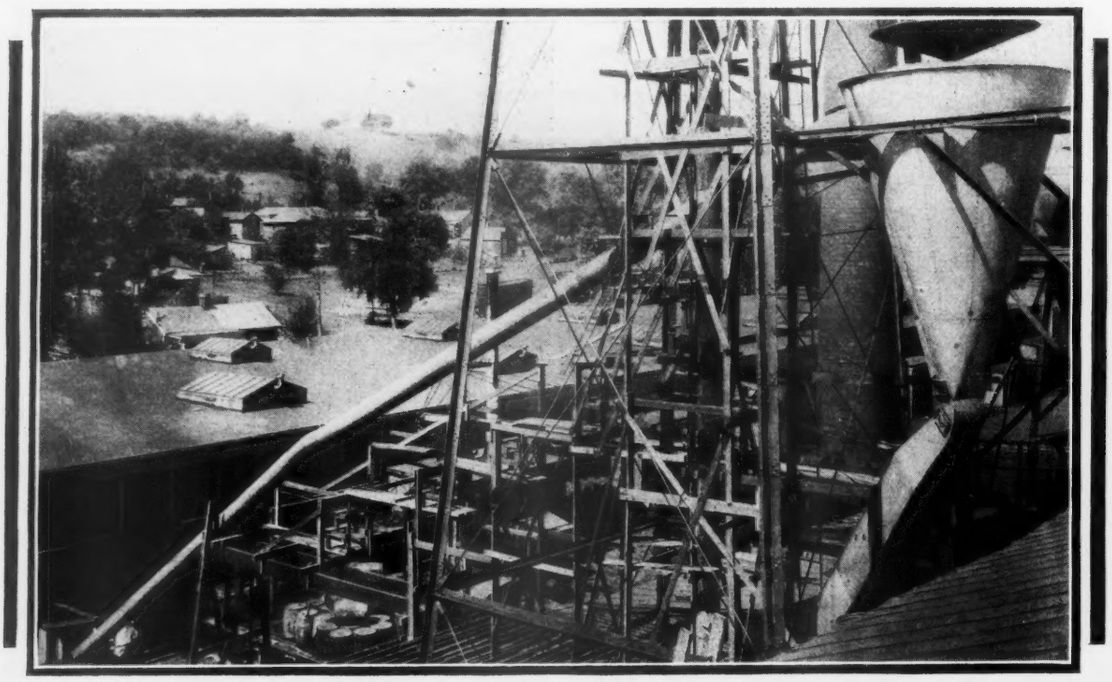
Group drive has been adopted by the National Cash Register Company for its newest building. Shown is a typical drive from 30-hp. motor to chain to line shaft. There are 32 single-spindle screw machines in this group.



Courtesy The Towmotor Company

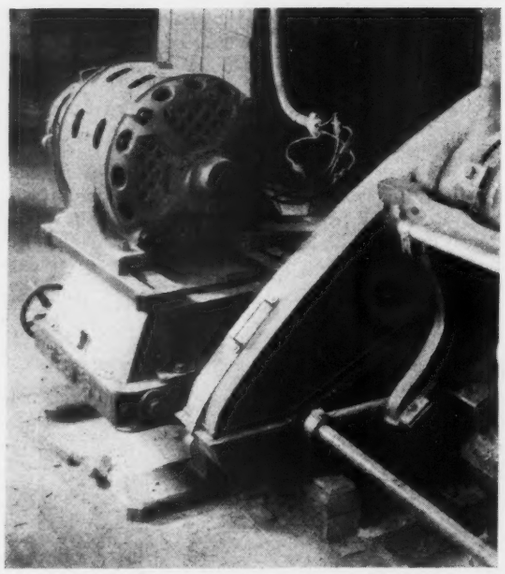
A large manufacturer of steel products puts gasoline tractors on both pulling and pushing jobs. Shown is a truck load of 20-ft. tubing being pushed into position for a swaging operation. Drivers are paid bonus for economical operation, provided, also, that tractors are kept in first-class mechanical condition.

MODERN EQUIPMENT AT WORK



Courtesy The Kirk & Blum Manufacturing Company

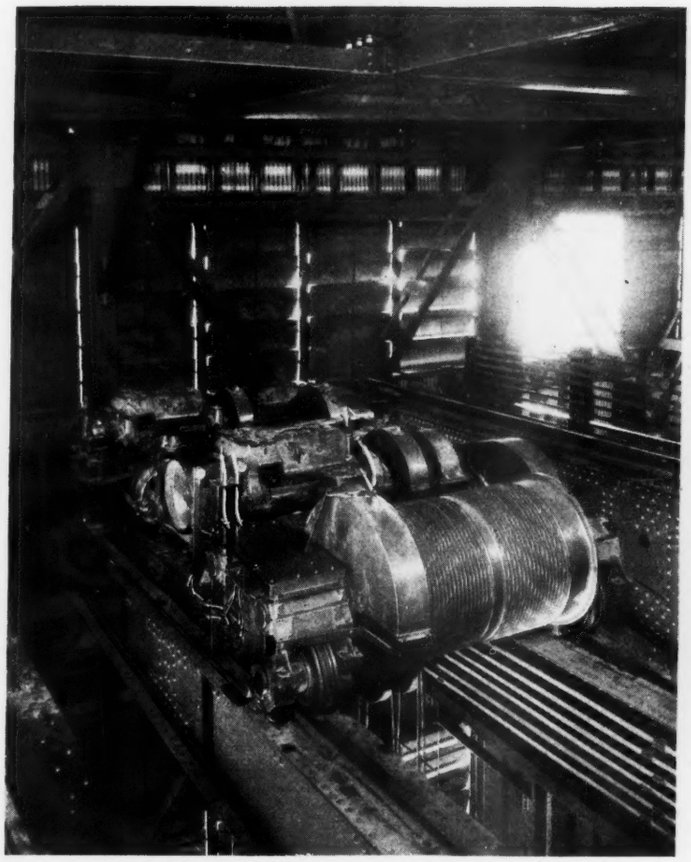
The Ohio Valley Pulley Works, Maysville, Ky., faced the problem of moving the scrap turnings, made in machining paper pulleys, to a hydraulic baler 300 ft. away. A pneumatic conveyor enabled them to handle the stringy, fibrous scrap. Six tons are handled in 45 minutes, one man feeding.



Application of variable-speed transmission to paper-box cutting and printing machine—National Box and Specialty Company, Sheboygan, Wis. The variable speed transmission is placed between motor and chain which drives press. Any speed within the range for which the press is designed can be obtained.

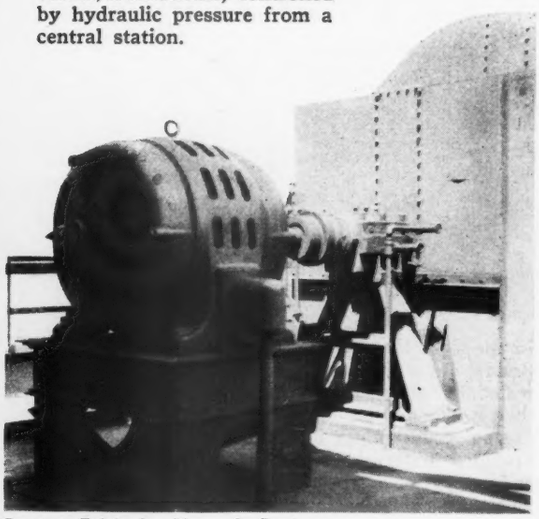
In fine work such as in screw making absence of shadows is essential. This view shows part of an installation of 42 lamps in a New York City plant where daylight is at a premium.

Courtesy General Electric Vapor Lamp Company



Courtesy Lubrication Devices, Inc.

Application of centralized system of lubrication to a 175-ton ladle crane of the Inland Steel Company, Chicago, Ill. The illustration shows the 40-ton trolley. Separate systems are installed on the main trolley and bridge. The system adopted distributes heavy lubricant by means of positive piston displacement metering valves, is automatic, controlled by hydraulic pressure from a central station.



Courtesy Fairbanks, Morse & Company

Outdoors and unprotected except for the protection built-in. A 75-hp. motor driving an induced draft fan at the plant of the Interlake Iron Company, Chicago, Illinois.

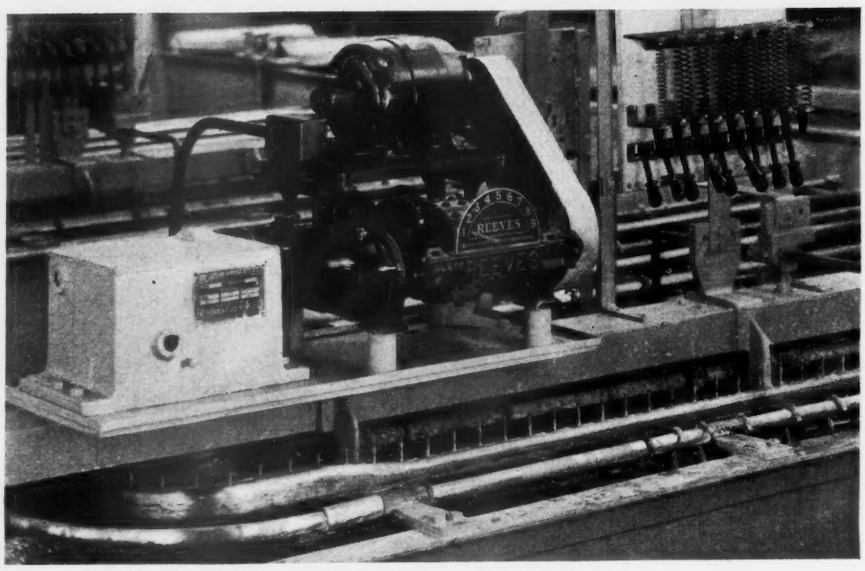
Courtesy Diamond Chain & Manufacturing Company

Positive ratio is necessary to assure maximum production. A paired, quadruple, 1-in. pitch, high-speed roller chain is used to drive the line shaft for cotton gins of Fest & Company, San Antonio, Texas. Reduction is 1.76 to 1.

MODERN EQUIPMENT AT WORK

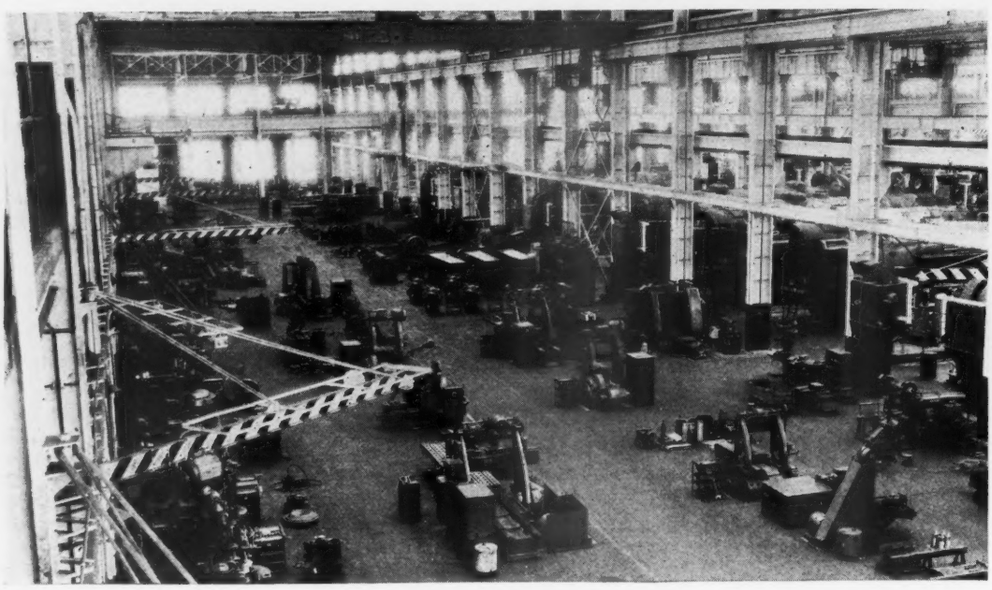
Courtesy Carrier Engineering Corporation

In the cigar factory of Waitt & Bond, Inc., Newark, N. J., which has a capacity of more than a half-million cigars daily, the air conditioning equipment provides uniformity for drying and processing. Departments on every floor of the factory are air-conditioned.



Variable-speed transmission regulating the speed of a plating conveyor in plant of Stromberg-Carlson Company, Rochester, N. Y. Installation consists of driving-motor, variable-speed transmission, and speed reducer. Thickness of plate depends upon speed of conveyor.

Courtesy Reeves Pulley Company



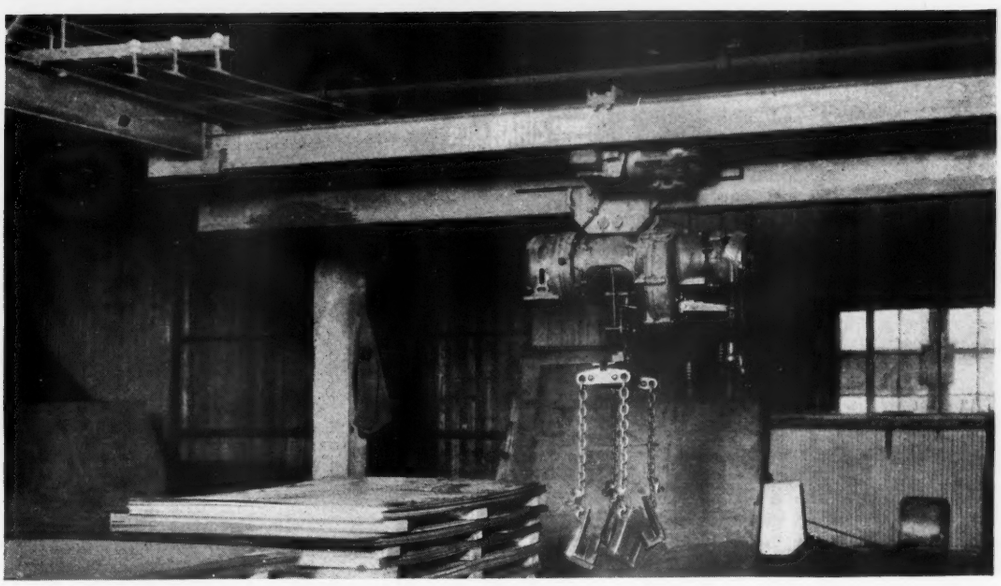
Electric hoists help to solve the lifting problem in the heavy machinery bay of the C. & O. Railway Company shops, Huntington, W. Va.

Courtesy Baldwin-Duckworth Chain Corporation

Using roller chain to take power from one motor for two line shafts.

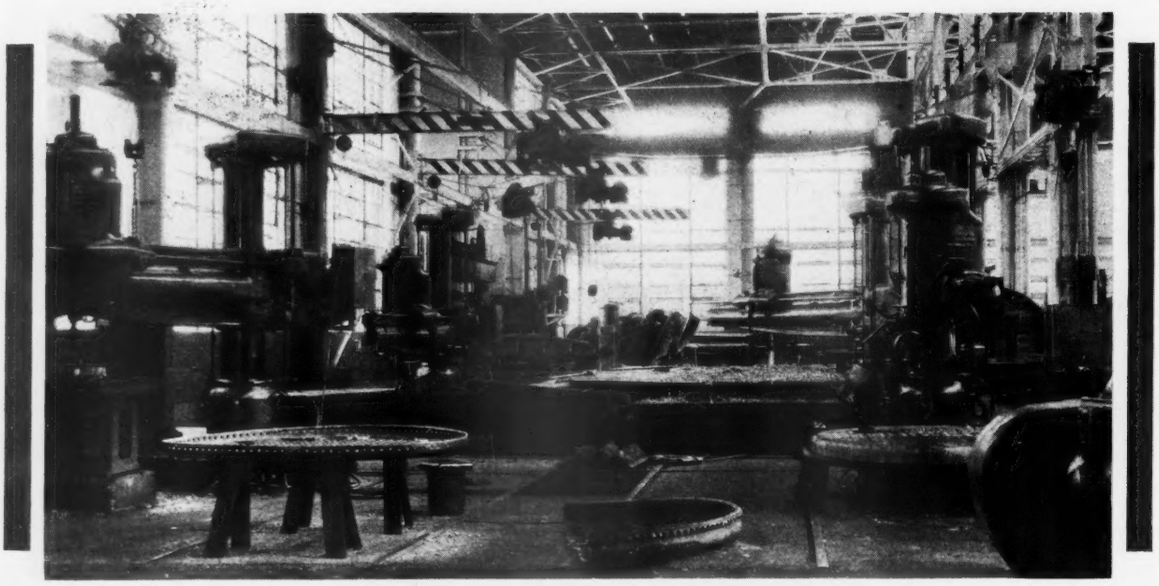
Equipment of the transportation department of the National Cash Register Company, Dayton, Ohio, consists of 38 industrial motor trucks, 20 small motor trucks, 5 lift trucks, 5 parcel post trucks. Uses: Transferring stock; transportation of tools; maintenance; handling dies; piling paper; stock tracing; parcel post service.

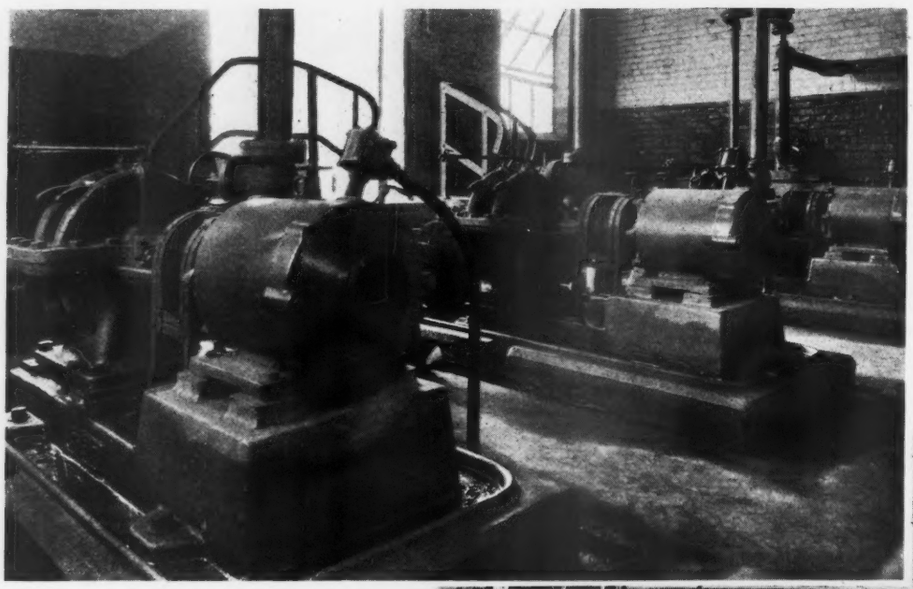
Two-ton, single-beam electric crane, transfer type with latches and stops—it's in the shops of the Clark Grave Vault Company, Columbus, Ohio.



Courtesy Maris Brothers, Inc.

MODERN EQUIPMENT AT WORK

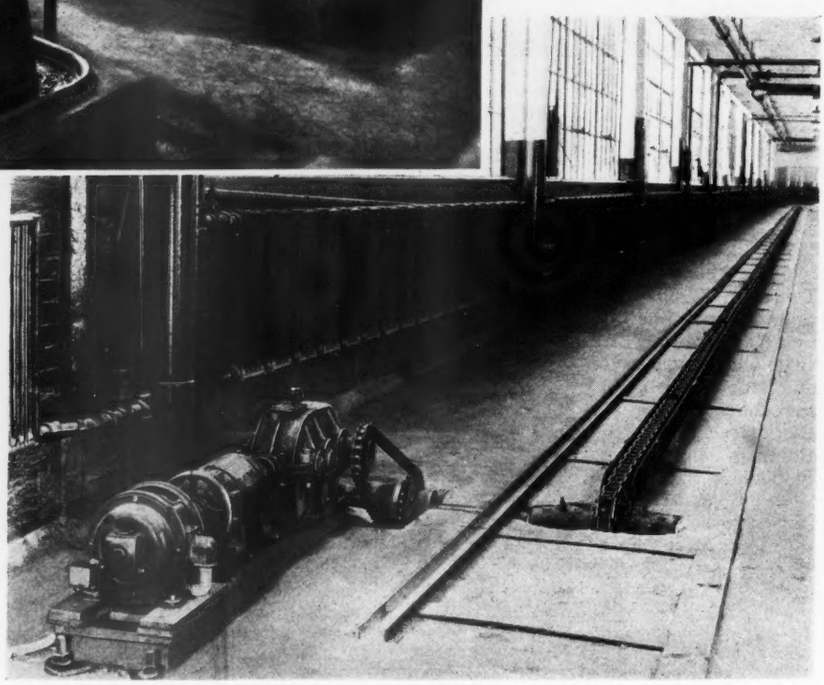




One-ton electric hoists on jib cranes in the Huntington, W. Va., shops of the C. & O. Railway Company. The boiler shop is shown.

Courtesy The Louis Allis Company

A group of explosion-proof motors pumping untreated naphtha to a battery of stills in a large Pennsylvania refinery. Exterior dimensions conform to standard motors. Fire walls are unnecessary.



Variable-speed transmission controlling speed of continuous automobile body assembly conveyor of the Fisher Body Company, Detroit, Mich. Regulation is from ¼ to 1¼ f.p.m. The drive consists of a 2-hp. motor, the transmission, and a 201 to 1 reducer.

Courtesy Stephens-Adamson Manufacturing Company

PLANT • ENGINEERS' • FORUM

* * *

Here is the twelfth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

* * *

Do Centralized or Decentralized Stores Better Serve Maintenance?

Forum fans had to forego the pleasure of a Fullleger-Shipman act last month because of the special "Modernization" issue. We left these two men discussing the question, "Do Distributors Serve Industry Economically?" Some difference of opinion, yes—and naturally. Now we find Frank and George returning from a ball game—not a big league affair, but THE plant game of the season between the stores and engineering departments to decide which should take possession of the company trophy—a silver bat. The stores department had won, which seemed to peeve Frank somewhat.

* * *

"They won again, George—drat 'em. Just like they win in the shop. If they kept stores as well as they play ball life would be easier for us. I don't want any of their ball players but I would like to take part of the stores away from them."

"What now, Frank? What's up?"

"Well, you know they added power plant maintenance to my duties a few months ago—and whether that should be a part of my job or belong to the incumbents of the power house is not for me to say. However, a nice little situation has come up. We took No. 4 boiler off the line Wednesday for stoker repair, and here it is Saturday afternoon when they discover that they are all out of side-wall tuyeres and we have to put her back on the line without 'em, I suppose. Probably more wall trouble as a result of it, and——"

"Maybe you didn't notify Stores about it last Wednesday," ventured George.

"Notify them? Why, yes we did, but even at that why should we be expected to notify them that we are going to need something which should be carried regularly in stock? It's listed, and they have a minimum quantity set up to carry. I tell you the system is wrong. The regular stock keeper told me Wednesday that they had 121 side-wall tuyeres in stock—more than enough for the job today, and I believed him. Now this morning I find he took that from his stock card which had not been kept up-to-date, as usual. They had a new stock keeper in there today from Dept. 406 Production Stores and he couldn't tell a tuyere from a ram box—just a kid. I have always said that the power plant should keep its own stock and this is just more proof. You see it's the same old story—the factory is down and off go the stock keepers because they're nonproductive labor, but the power house runs just the same; in fact, these are just the days when we should do our repair work, and we need a stock keeper the most."

"I know, Frank, but that would never do. If they let you run your own stock room, then Billings would have a stock room in the forge shop, Jack Canfield would have one in the foundry, and the first thing you knew there would be a dozen stores departments all under different systems, many improperly kept, and a mess that could never be unscrambled at inventory time."

"Unscrambled," mused Frank, with a smile. "Don't we have to go into that stock room about every two months as it is and find things they didn't know they had either because the records were wrong or because they are not familiar with the stock? If that isn't unscrambling, I never saw an egg."

"I agree with your statement of conditions, Frank, but I am not so sure your solution would help things. You must remember that we fellows in the factory are bound to have a sort of worm's-eye view of things; we would apply to our individual problem a solution which might be a complete failure if applied to the

whole. You know the power plant stock, and the system works beautifully there."

"Well, but George, the needs of production stores is one thing and power plant stores another. When one is shut the other is open, and I can see no reason why we should not have a key to our stock room and account for our stock the same as anyone else. Then Gus would know what he has and things like this today wouldn't happen. I'll bet Gus could take an inventory of power plant stores blind-folded. He is handling those parts on the repair gang every day and doesn't need to be told. Not only that, but we would eliminate a special store keeper on week ends, that is, if we are lucky enough to get one."

"The question you have uncorked here, Frank, is whether specialized activities in a plant like this should be centralized under one head, or whether they should be parcelled out to the different divisions—decentralized. You probably admit that no one but the power division should generate power—that is centralization; but you do not admit that store keeping should be centralized. Our management has tried and believes in centralization and there are evidences they are right, I think."

"Yes," replied Frank, "and evidences that they are wrong. You remember when you first came here the machine repair at the power house was done by the general machine repair division?"

"Yes."

"All right, then you recall that Ben Currier was foreman of that department and every time we got in a tight pinch at the power house he always had an alibi of some kind; usually that his man assignment was cut and he couldn't fix the pump till next Tuesday, or that he was not permitted to work overtime because the plant was on short production. Well, production didn't cut much figure with steam demand to heat the factory and we hired the work done outside for a while. That wasn't so good, for Ben was the best machinist I ever saw and the outside work was expensive. You know the answer. We were finally permitted to take one of Ben's best men as a foreman and now that we have our own machine repair gang everything is fine."

"Are you sure, Frank, you don't imagine everything is fine just because the men are in your own department?"

"Operating costs talk, George, and they have gone down since then."

"Maybe so, but isn't it a fact that at times there has not been much work for your machine repair gang and rather than break up the crew they were kept at some unnecessary work; work that could well have been delayed, at least? And how about machines? Hasn't it been necessary to provide special machine tools and a place to operate them which would not have been necessary if the work had been centralized?"

"Say, George, you talk like a book. Weren't the machines discarded by the production departments, and wasn't the space unused before? And as far as loafing or doing unnecessary work is concerned, that is a myth. The condition of the plant speaks for itself. It is perfectly plain that the decentralized machine repair has been a great success, and the same would apply to the stock room."

"You are certainly sold on the idea of decentralization, but in spite of your perfectly good arguments you haven't sold me. What would you say if I told you that the sheet metal department had complained of the service they get from your steam fitters? Would you still be willing to turn that work over to them and reduce your own department by two or three men in support of your theory?"

"I most certainly would not. A steam fitter must have a knowledge of the piping systems in the plant, and I would oppose having Tom, Dick, and Harry tinkering with the pipe lines. We'd be in an awful mess if everyone in the factory had his own gang of fitters. You remember when those three men were injured over there by Bldg. 71. Green men they were—shut off a steam line to do some work over in the forge shop, then built her up just like they cut her off. Wham! and an anchor let go and if it hadn't been for that new tunnel opening nearby they never would have got out alive. Well, they were hammer men who thought they would speed things up by doing a little job themselves, and by the beard of the prophet they nearly did it. No, George, the steam fitters should all be under one head."

"Yes, but aren't you drawing conclusions from a part of the work that has never been in question? I agree that important tunnel lines should never be touched by any except the fitters especially in charge of them, but that doesn't mean that Jack Canfield over in the foundry should have a gang of men standing idle for half an hour when the hose on an air hoist breaks just because it takes that long to get one of your fitters on the job. Don't you think he should have at least one fitter on his gang to do jobs like this?"

Frank didn't answer. Maybe he had the answer, but maybe he didn't. However, the two men had reached Frank's gate and little Frank was there to greet him—so no more shop!

* * *

In their appearance this month Frank and George have chosen to discuss a question as it relates to the power plant—a lucky choice because ordinarily the power plant is a distinct unit. But the principle involved applies throughout the industrial plant.

Countless engineers have experienced that helpless feeling resulting when equipment is down and the store cupboard is bare. How should the thing be handled? Can centralized storekeeping prevent such situations? Or is a certain amount of decentralized storekeeping justifiable? Your comments should reach the editors within the next three weeks.

Answers to previous questions will be found on the following pages.

READERS' ANSWERS

to previous questions

Do Distributors Serve Industry Economically?

(Question presented in the June issue)

GEORGE and Frank are now discussing a question that has been uppermost in my mind for several years. The price of buying from the distributor or dealer in emergencies and from the manufacturer when there is no rush is the policy of a great number of plants.

This out-of-town buying is not confined to ordering direct from the manufacturer. Very often orders are placed with an out-of-town distributor because he can make a slight reduction over the local dealer, that is, on some items.

The prevailing belief that the manufacturer pays a commission to the dealer in the neighborhood where his goods are sold isn't always justified. I know of one manufacturer who refuses to pay any commission to a dealer when the goods are ordered direct. This policy is founded on his belief that if a commission were paid the dealer would lessen his efforts as a salesman.

But with a little thought in connection with this human frailty, it will be seen that it can work both ways. When all purchasing is done direct, the manufacturer has a chance to adopt the attitude that he will get the order anyway and will render very little service to the customer. In fact, one manufacturer, who was getting all of the orders from a certain plant direct, never had a representative in the plant during a period of four years. This demonstrated his attitude very clearly.

I know of an instance where a dealer handled this manufacturer's goods, went into the plant, worked on new problems, sold the equipment, and then the plant turned around and ordered direct from the manufacturer.

Another dealer was doing field work among plants that had a home-office purchasing department, off in another part of the country. When the dealer sold the product to the local plant, the order was sent to the purchasing department, which placed it with a dealer in the home-office territory. The field representative received a commission on the sale if he could convince the manufacturer that he was responsible for the sale. But his commission was split with the dealer with whom the order was placed, and who put no more effort on it than merely to forward it to the manufacturer.

The mill supply house certainly does fill an economic function, one that most manufacturing plants fail to use to their own best advantage. The local dealer usually has all of the general or standard commodities that the plant needs. And usually these items are made by the same manufacturer from whom the plant will order in an out-of-town market.

The local dealer is of service to the plants in his neighborhood in many ways often overlooked. For instance: In the electrical maintenance of a plant, numerous testing instruments are needed from time to time, instruments that the plant cannot afford, just doesn't have, or would carry as a burden. These instruments usually are obtainable from the local dealer at no more cost than a few minutes spent telephoning for them. One dealer of whom I know will deliver these instruments to the plant and call for them, not even making a charge for the recording charts used.

Then there is the case of special expensive tools that the plant needs yet isn't justified in purchasing. A good example is a commutator mica undercutter that will cost as much as $150. This sum, at 5 per cent carrying charges, costs the purchaser $7.50 per year. The same holds true for commutator grinding equipment.

Very often a piece of equipment will fail when there is no spare available. The local dealer usually has it. If not, he knows where it can be obtained and will assist the plant in getting it.

Prompt delivery of supplies is of vital necessity to the maintenance program. The longer it takes to obtain an article, the greater the amount that has to be purchased and carried in stock as insurance against production delays. This is responsible for the large storerooms in some plants.

With the plant's standard commodities in the local dealer's warehouse, the plant is relieved of investment in space, personnel, and insurance.

There are many plant men who never get around to see what the other fellow is doing. The dealer's representative is a good go-between in helping these plant men to solve their common problems. These representatives usually are graduate engineers or come from the school of "hard knocks." In either case they have personal service to render.

As to prices. There is considerable food for thought hiding under the blanket price. I do not wish to be misunderstood by anyone, but in the rush for low

C. SHAFER
Research Department, Libby, Owens, Ford Glass Company, Toledo, Ohio. His work has given him close contact with maintenance.

C. C. WILCOX

Superintendent, Power Division, Studebaker Corporation, South Bend, Ind. Mr. Wilcox is responsible for the question concerning "centralized or decentralized stores" in this issue.

prices some purchasing agents may overlook a few things that add to price. For example: A shipment of electrical items was purchased at a saving over the local dealer's price of one-tenth of a cent on each item. They were shipped by parcel post, which more than offset the small difference in cost. They were made by the same manufacturer who supplied the local dealer.

Again, an out-of-town purchase was made on some items at exactly the same figure quoted by the local dealer. The purchaser was out 40c for parcel post charges.

A purchase of conduit was shipped by freight. After the freight bill was paid, there appeared to be a saving of 83c over the local dealer's price. Now add the carrying charges of this conduit, and the cost of a trip to the freight depot for a truck and driver.

Better service and quicker adjustments in case of unsatisfactory or damaged goods are made through the local dealer than can be made by means of explanations and correspondence with the distant dealer or manufacturer.

MARIN PHILLIPS, *Electrical Superintendent*
International Paper Company
Niagara Falls, N. Y.

I WAS glad to see the matter of the mill supply house discussed in your June issue as there seems to be a very definite opinion gaining ground at this time that the jobber can and should be eliminated. Many buyers today seem to be of the opinion that if they could make all of their purchases direct from the manufacturer they would effect quite an economy. This is not my opinion, and I believe that if the matter is given sufficient consideration it will be seen that the economies will not be as great as would appear on the surface.

My experience has been that most supply houses perform a worth-while function in warehousing material and being able to supply it immediately as it required for maintenance work. Where the manufacturer attempts to distribute his own material it is necessary for him to employ a much larger sales and service force and to maintain warehouses at convenient points around the country. It will be seen readily that his sales expense would be much higher than where he sold through a jobber, so that the cost to the ultimate consumer would be practically the same. Consumer cost carries much weight in any economic problem.

My experience has been that the average jobber, when called in for technical information, is in a much better position to give unbiased advice inasmuch as he usually represents more than one manufacturer in each line and can therefore conscientiously recommend the type and make of article best suited for the job. The manufacturer's representative is, of course, interested in selling only his own product and will often recommend it for work for which it is not ideal.

The present tendency is toward hand-to-mouth buying which makes the mill supply house a cog more important than ever in the modern business machine.

C. W. SCHWABE, *In Charge of Mechanical Department*
Mallinckrodt Chemical Works
St. Louis, Mo.

SUPPLIES used by industrial plants can roughly be classified into two general divisions: (a) equipment adapted especially to the production of special lines, and (b) equipment of a general nature used by all plants.

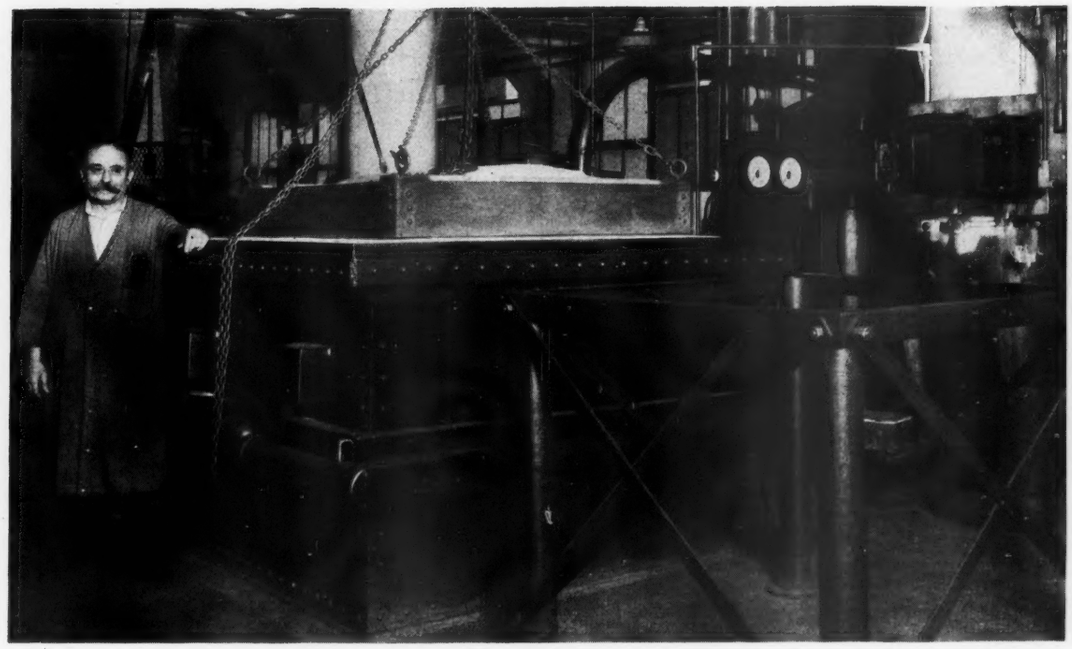
Sometimes the specialized equipment being used in certain localities is large enough in volume that the manufacturer is justified in having a special representative. He can sometimes go farther than that and carry some repair parts in a warehouse in that center. The future business that can be developed influences these items. As a rule, the equipment in the first classification and its repairs should be purchased direct, and that of the second class through distributors. The volume handled will have much to do with the method selected.

The second class of equipment, or equipment of general use such as the mill supply houses carry, should be purchased through the mill supply houses, on account of price and delivery. The general run of maintenance work does not involve any such quantity of material as to warrant price concession. Sometimes a repair job is of such size that material may be bought direct, but the occasion is rare. Under such circumstances delivery dates must be considered. With efficient record systems in use it is possible to keep maintenance items in stock so that there will be a minimum supply on hand. In effect, however, the distributor is caused to carry inventories of these items for a number of plants.

In my opinion the technical help received from distributors is often overestimated, and has often been exaggerated. In most concerns the representatives do not get beyond the purchasing agents to the ones actually on maintenance work. This is as it should be because the maintenance men and distributor salesmen handle such variety, or so many lines, that they are not experts in any particular line, and have to call in a factory representative if anything special is up for discussion. New developments are announced in the trade magazines and in this way the plant engineers are kept informed.

The observations of a number of years in maintenance work indicate that supply houses have a definite place. The close contact with their salesmen does not mean anything special to the consumer, and it has often been exaggerated. There is an advantage in direct dealing in obtaining exchanges, deliveries, and savings in inventories.

JOHN P. SIMONS, *Plant Engineer*
Industrial Rayon Corporation
Cleveland, Ohio



Pit-type annealing furnace, 75-kw. capacity. Automatic temperature control and a time clock are the only attendants required for 16 of the 24 hours during which it is in operation.

In One Plant—64 Applications of Electric Heat

By WIRT S. SCOTT

Special Representative Westinghouse Electric and Manufacturing Company, Mansfield, Ohio.

How the Union Switch and Signal Company applies electric heat in capacities ranging from 500 watts to 50 kilowatts.

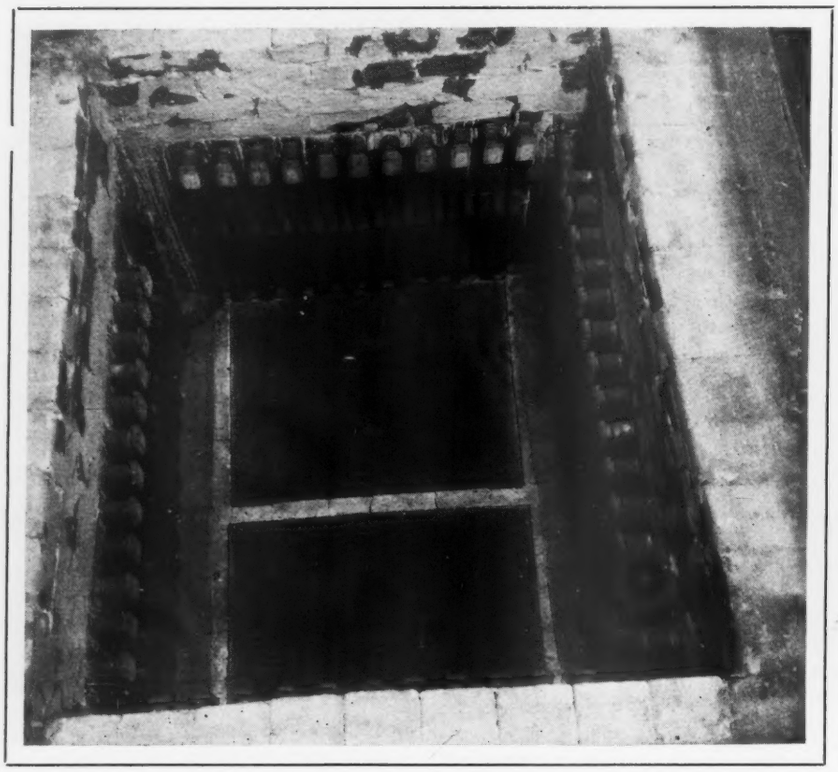
TRAIN signaling and controlling apparatus is the product of the Union Switch & Signal Company, Swissvale, Pa. That such equipment should operate perfectly under all conditions is apparent. Uniformity of the physical structure of materials is an essential. Careful inspection and testing can be depended upon to disclose inaccuracies of manufacture, but the more rigid the standards the more expensive the inspection and testing and the more the rejects. Heat-treatment has a considerable bearing on the quantity of rejected parts.

Early experiments with electric heating showed that with properly designed equipment the results obtainable with this supposedly expensive energy were as follows:

1. Better quality, resulting in increased life of the parts heat-treated.
2. Rejects due to heat-treatment reduced practically to zero.
3. The assurance that every piece was properly heat-treated.
4. A reduction in labor for heat-treating.
5. A product of better finish at less cost.

Electric heating is used now for every heat-treating operation: Annealing, carburizing, hardening, tempering, cyaniding, bluing, oxidizing copper disks, enameling, coil baking, spring tempering, lacquer drying, paint drying, melting (of wax, paraffin, rosins, solder). It is used in numerous small devices where only a small amount of heat is required, and the development and research laboratory is completely electrified.

Such extensive use of electric heating did not occur all at one time. Since many of the applications were duplicates, it was easy to determine



Looking down into the pit-type furnace. Ribbon resistors are mounted on the sides and under the floor plates.

whether or not electrification should continue. Each new application produced results justifying itself, and increased the confidence of the management; eventually complete electrification resulted.

The reasons ascribed for this wholesale electrification are about as follows:

1. Ease of duplicating desired results.
2. High-grade quality of work.
3. Low rejection.
4. Can use a maximum of unskilled labor.
5. Always know what the production rate will be.
6. Equipment can be located conveniently with respect to the preceding and succeeding processes, and with respect to the shop.
7. No heat, gases, or fumes given off.
8. Silent operation.
9. No danger from fires or explosion.
10. Ease of starting and stopping.
11. No attention required for regulation of temperature.
12. Laboratory tests for the determination of the correct heating cycle for a given product can be duplicated with extraordinary ease.
13. Maintenance is a negligible factor.

The experience of the Union Switch & Signal Company shows that the cost of heating, whether it be by electricity or other means, is a minor part of the manufacturing cost and that the production results are of far more importance than fuel bills.

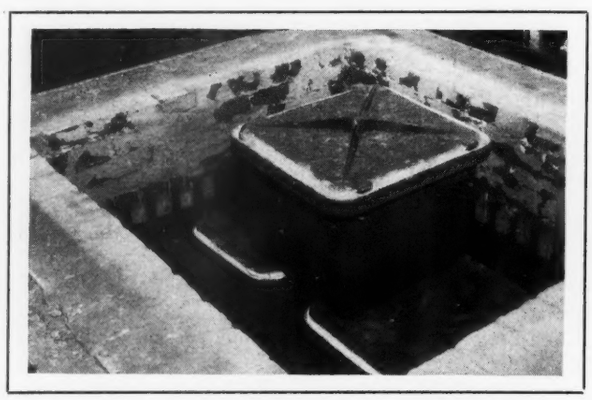
One of the most important applications is an annealing operation, desired also because it reduces the residual magnetism in the steel to a definite minimum. Magnet cores and armatures used in connection with electrically operated semaphores are energized for the operation of the signal to give a certain indication and when de-energized show a "stop" indication. In other words, in case of failure of electric power, the "stop" signal will show.

The removal of the residual magnetism is accomplished by exact heat-treatment. Two electric furnaces of the carbon-plate type were used at first. They demonstrated the improved quality that could be expected from electric heat-treatment, and gave very satisfactory results despite the heavy maintenance charge caused by frequent replacement of the carbon-plate resistors. One operation requires a temperature of approximately 2,000 deg. F. and the metallic resistor furnace had not been developed to the point where the manufacturer would recommend it for this temperature.

In May, 1923, a pit-type metallic-resistor furnace was installed. The furnace is rectangular in section, having a working space 40 x 40 x 34 in. and an electrical rating of 75 kw. Heating elements in the form of heavy nickel-chromium ribbons of return bends are mounted on the four side walls and on the bottom. Nickel-chromium plates cover the bottom heaters and support the charge.

Heat-treatment of a certain class of small parts has been developed for continuous operation. The parts are given a thorough saturation at a predetermined temperature, with variation not greater than 7 deg. plus or minus. There is secured a dead soft anneal, with product as free from scale as possible.

The parts are packed in nickel-chromium alloy boxes, 12x16x24 in., and the box lid is sealed with fire clay. Three boxes per charge are placed in the furnace, two on the bottom and one resting on the top of these two. The total charge weighs approximately 5,200 lb., about equally divided between weight of boxes and the work. This work is ground to 0.001 in. before treatment; it is obvious that a product free from scale is essential.



Showing method of charging the pit-type furnace with annealing boxes. Permissible temperature variation is 7 degrees.

A hearth-type furnace for carburizing, hardening, tempering. Brought up to temperature each morning automatically by means of time clock and automatic control equipment.

Complete cooling of the furnace is never permitted. Just as soon as one charge is removed another is placed. From five to six hours are required for the furnace to reach the proper temperature, which is held for three hours. Slow cooling to 1,100 deg. F. over a period of from 15 to 16 hours follows, after which the boxes are removed and allowed to cool in the air. After heat-treatment, parts are individually tested for their characteristics.

The pit-type furnace is used occasionally for annealing forgings and other products. At all times it is under full automatic temperature control. Magnetic contactor switches, recording and controlling pyrometer, and a time clock control the heating cycle, permitting 24-hr. operation with no one in attendance after the regular 8-hr.-day period. The entire cycle consumes about 24 hours; the charge is placed during the day and the current is turned on. The time clock is set to cut off the current at a predetermined time, depending upon the weight of the charge and the temperature of the furnace at the time of charging.

A test made by the Union Switch & Signal Company some time ago showed:

Total number of heats	94
Total number of boxes	145
Weight of work per box	1,200 lb.
Average weight of work per heat	1,848 lb.
*Total weight of work, 94 heats	174,000 lb.
Total current consumption	39,480 kw.-hr.
*Pounds of work annealed per kw.-hr.	4.4
Cost of electricity per kw. hr.	$0.012
Cost of electricity per lb. annealed	$0.00272
Repairs to furnace to date	None
*Duration of test	16 months

With the pit-type furnace now used the results are:

Number of charges per month	26
Average weight of work per charge	2,600 lb.
Average pounds per kilowatt-hour, estimated from previous test	6
Total kilowatt-hours per month	11,266
Present cost of electricity, less than 1 cent per kilowatt hour	$0.01
Total monthly cost, at 1 cent	$112.66

* AUTHOR'S NOTE: Since this test was made, it was found practicable to double the weight of charge per heat. At that time the production was only one-fourth of what it is to date. With the increased weight per charge, and the elimination of the cooling of the furnace between heats, the pounds of work annealed per kilowatt-hour doubtless has greatly increased, although no test has been made to determine the amount.

The second and concluding part of the article will be published next month.

Bonus for Maintenance Work—*Discussion*

RELATIVE to your editorial in the May issue on bonus for maintenance department workers:

A sliding scale of bonus, with the amount of bonus earned determined by the week's performance rather than by a record of each individual job, should be used on account of the possibility of wide variations in the ratio of time allowed to time taken.

At the end of the week the total of the times taken is divided by the total of times allowed. If the quotient, or ratio, is 1, a bonus of 34 per cent of the weekly wages is paid. If time taken is 40 per cent in excess of time allowed, no bonus is paid. There is a rising scale of bonuses between unity and 40 per cent. If time taken is less than time allowed, a proportionately greater bonus is paid but at a slightly different rate, so that a 100 per cent bonus is earned when total time taken is one-half of the time allowed. The characteristics of this plan aptly designate it as a merit bonus.

GEORGE H. GUNN
Maintenance Section, Engineering Department
Naval Aircraft Factory
Upper Darby, Pa.

Correction

UNDER *Example 2* in the article entitled "Some Pointers on Testing Watt-Hour Meters," by Nicholas Cook, page 309, June issue, the transformer ratio was given as 40/1; also the average load was indicated as 15,400 watts.

In the first case, the ratio of a 400-amp. current transformer having a 5-amp. secondary is 80/1, which figure should have been used in the example.

A typographical error is responsible for the load figure which should have been 154,000 watts.

BOOKS *for your personal library*

Mechanical Engineers' Handbook

Prepared by a staff of specialists: Lionel S. Marks, Professor of Mechanical Engineering, Harvard University, editor-in-chief. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Third edition. Flexible binding, 2,264 pages, thumb-indexed, over 1,300 illustrations and diagrams. Price, $7.

DURING the six years that have elapsed since the appearance of the second edition of this great work, many developments have been made in mechanical engineering, both in practice and in the knowledge of fundamental theory. The present edition represents a thorough revision, with the addition of much new material; many sections have been completely rewritten.

Treatment of standards and practice has been brought up to date, and physical data have been revised to give the best current values. Developments in special fields, such as welding, have been covered by more detailed discussion. In addition, a number of new subjects, including industrial combustion furnaces, electric furnaces, and carbonization of coal, have been treated. As a result, about 270 pages have been added to the handbook. More than 70 specialists have contributed to the new edition, in consequence of the subdivision of the major portions into smaller sections, in order to take full advantage of the increasing specialization in mechanical engineering.

High-Voltage Oil Circuit Breakers

By Roy Wilkins, Consulting Engineer, Pacific Electric Manufacturing Company, and E. A. Crellin, Assistant Engineer, Division of Hydro-electric and Transmission Engineering, Pacific Gas & Electric Company. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Cloth, 298 pages, 121 illustrations. Price, $4.

IN this volume, the authors have presented a chronological account of the development of the high-voltage oil circuit breaker, with a discussion of the theory of its action, descriptions of modern forms, and an account of the results of many field tests.

Descriptions of modern high-voltage oil circuit breakers are given in considerable detail. Recent developments in operating mechanisms, designed to meet the need for greater speed and better control, are described and discussed. One of the particularly interesting features is the account of tests made with relatively high charging currents as such conditions can be obtained only in the field.

There has been a need for a comprehensive treatment of high-voltage oil circuit breakers; it has been well met in this book.

Engineering Kinematics

By William Griswold Smith, Professor of Engineering Drawing, Northwestern University. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Second edition, cloth, 335 pages, 420 illustrations. Price, $3.50.

KINEMATICS, which is defined by the author as the science of motion, may be regarded as one of those dry-as-dust subjects, but he has labored hard, and done much, to show the importance of the subject in our industrial life. Hence, in the first edition although the fundamental principles of motion were given first consideration, the application of these principles to the design of the innumerable agencies transmission, transportation and production were given as much attention as possible.

The present second edition has been made necessary by the revolutionary changes in machine design and other developments during the past few years. Considerable new material has been added, with some helpful rearrangements in the order of presenting the subject. The examples and illustrations have been drawn largely from catalogs, handbooks, and industrial literature, with the result that they have a very practical slant that adds much interest to the study of this important subject.

New Building Estimators' Handbook

By William Arthur. Published by the Scientific Book Company, 15 E. 26th St., New York, N. Y. Flexible covers, 5x7 in., 1,022 pages. Price, $6.

APPEARING first in 1909, and published then by the David Williams Company, this book is now in its fifteenth edition. That in itself is something of a recommendation.

For anyone engaged in new construction, or in maintenance, the handbook is a good working tool. It provides specific data on the cost of doing construction work, pertinent to all sizes of buildings, involving the use of all kinds of materials.

Measurements, excavating, filling, piling, brickwork, structural iron and steel, fireproofing, sash, plaster, glass, roofing, and electric and conduit work are a few of the subjects treated in this volume.

Electricity for Beginners

By Edward Harper Thomas, E. E. Published by The Norman W. Henley Publishing Company, 2 West 45th St., New York, N. Y. Size 5x7 in., cloth, 196 pages, 24 illustrations. Price, $1.50.

AN elementary treastise, offered as a simple comprehensive text on the fundamentals of the subject, the first purpose of which is to be entirely non-technical, and to lay the foundation for those who may desire to pursue the study of the science of electricity.

Life Expectancy of Physical Property

By Edwin B. Kurtz, Head of Department of Electrical Engineering, The State University of Iowa. Published by The Ronald Press Company, 15 East 26th St., New York, N. Y. Cloth, 202 pages, 89 illustrations, 60 tables. Price, $6.

IMPORTANT as data on the life of equipment are to accountants and engineers, little published information of this sort has heretofore been available. In this volume there are presented such records on the life of equipment as the author has been able to gather over a period of many years. These mortality tables have been carefully studied and analyzed. The life characteristics of many items of physical property have been calculated and analyzed, and such relations as could readily be discovered were noted.

With this background as a basis, the author has developed the mathematical equations and their corresponding curves which represent graphically the seven types of experience into one of which the mortality facts for any type of physical property must fall. The calculations and formulas required to determine average life, life expectancy, probable life, and annual renewals have been worked out in detail, so that they can readily be applied to any class of property for which data is available.

This work deserves the serious attention of every engineer and accountant who is concerned with the appraisal or replacement of equipment, and should do much to put the consideration of depreciation and the problems of obsolescence on a sound basis of fact.

AROUND *the* WORKS

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

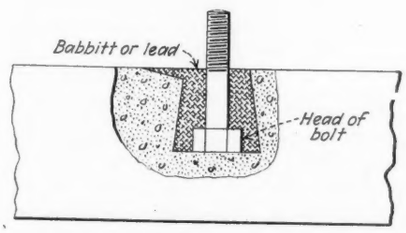
Method of Anchoring Bedplate Bolts in Concrete Floor

WHEN anchoring electrical machinery to a concrete floor, I have found the following method effective. It makes possible an ease in lining up that is not to be had with cinch anchors.

Mark the location of the bolt holes on the floor and then drill the holes in the concrete, tapering outward at the bottom, as shown in the accompanying illustration, with a short gutter in the floor leading to the bolt hole. Then set each bolt in place with its head down, the other end of the bolt extending through the bedplate or the leg of the machine to be set. After the nuts are run up almost to their holding position on the bolts, line up the bedplate or the machine in its approximate position and pour lead or babbitt into the gutter until the hole is filled. It will not be necessary to pack the lead or babbitt on account of the wedge shape of the hole. As soon as the lead is poured, the machine may be carefully lined up and then bolted down securely. This method is usually better than filling the holes with concrete. Furthermore, the bolts will hold the machinery more solidly than with cinch anchors.

R. M. THOMAS.

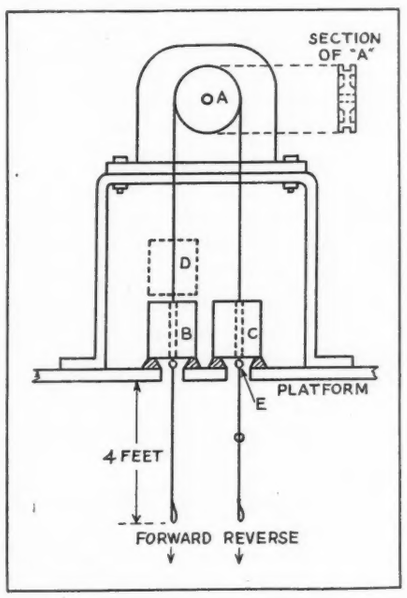
Denver. Colo.



Lead or babbitt is poured into the gutter to the left of the bolt until the hole is filled to the level of the floor.

Weights Provide Safety for Floor-Controlled Crane

RECENTLY a cab-controlled crane was remodelled for floor operation by means of ropes. The drum controller was retained but installed in a horizontal position and equipped with a wheel in place of the familiar handle. This part was located in the odds and ends of the electrical shop. However, this arrangement alone would not have made a satisfactory installation without some means of throwing the controller to the "off" position. Absolute safety was necessary in case the man operating the crane from the floor should stumble and lose the rope, or in case the rope should break with the controller in the running position.



Pole pieces, B and C, used as weights bring the controller to the neutral position as soon as the cords are released.

How the change-over was made safe is shown in the accompanying illustration. Two weights, *B* and *C*, are old pole-pieces salvaged from a wrecked motor and weigh about 16 lb. each. Through the center of each was drilled a ½-in. hole. Passing through *B* and *C* is a piece of ¼-in. steel cable which is fastened to the operating wheel *A*, shown in the section at right. Crosby clips, *E*, below each weight allow the following operation: When the steel cable on the right (reverse direction) is pulled, by means of sash cord fastened in the eye of the clip, the steel cable passes freely through weight *C* while *B* is being pulled upward to the position shown in dotted lines at *D*. In case the rope breaks weight *B* returns to its normal position, bringing the controller to the neutral position. Weight *C* operates similarly but in the opposite direction of crane travel.

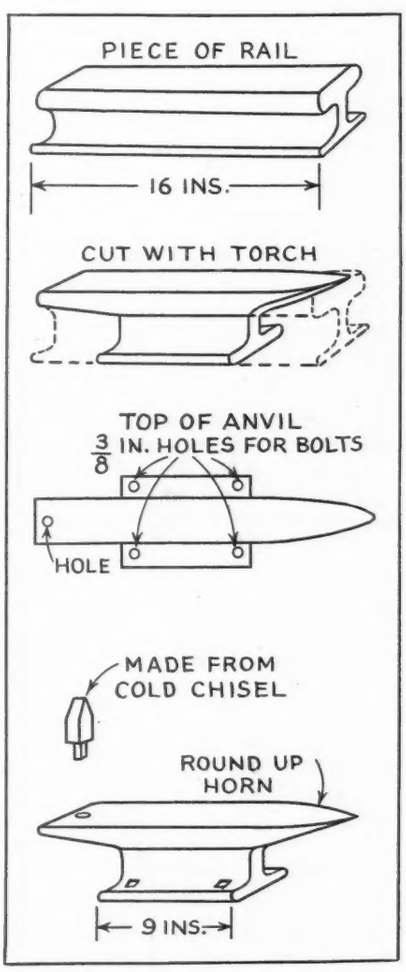
Of course, a heavy spring return could be used but inasmuch as none could be found we used the method outlined to secure the desired result.

Master Mechanic, Cold Spring, Minn. CHAS. A. PETERSON.

Handy Bench Anvil Made from Piece of Rail

WE recently made two bench anvils from pieces of scrap rail and find them so convenient that the method of making them is hereby passed on to others interested.

Pieces of 60-lb. rail were used, cut-



Progressive steps in turning a piece of rail into an anvil.

ting them with an acetylene torch, as shown in the sketch. Shaping the horns was a job for our blacksmith, after which the anvils were bolted to the 2-in. planks forming the top of our work bench. The cutters for the top of anvils were made from cold chisels, ground down to fit the ½-in. holes. We find the anvils very useful for all sorts of light work going through the shop.

C. A. P.

Cold Spring, Minn.

Hydraulic Method Adopted for Handling Refuse Sand

MOVING about 500,000 lb. of sand refuse material per day and disposing of it in an economical manner is no small task, yet it is being done in a mid-western foundry. The refuse material is burnt core sand and molding sand produced by the molding operations, and comes from the casting cleaning department.

From this department the refuse sand is elevated into a large hopper of one-car capacity from which it is dumped into railroad dump cars below. Daily, five cars of this material, each car holding approximately fifty tons are taken away by the switch crew and dumped along the tracks in outlying low districts.

It is obvious that the dumping of the cars merely deposits the sand in a high ridge along the track, and some means must be employed to level off the pile to make room for the next dumping. Several methods of disposing of this material were tried, and all cost data were carefully compiled to provide a means of comparison before finally adopting a definite way to accomplish the job. The methods tried, and their itemized costs are outlined in order as follows:

1. Clearing and leveling by hand, that is, laborers using shovels. This method required 7 men working nine hours per day. At a labor cost of 40c an hour, the cost per ton was calculated to be $0.10.

2. Using a slip drawn by a kerosene tractor, which required one tractor operator and two men on the slip. This method involved the anchoring of a cable sheave across a pond to a tree about 100 ft. distant. To hold the cable off the slough bottom twin barrels were attached to it at 40-ft. intervals. One end of the cable was attached to the slip; the other end being fastened to the tractor. A draw cable was then attached to the slip through a sheave ahead of and to the tractor. The material had to be slipped off on the water side making it necessary to work the tractor on the opposite side, and in the reverse direction. All this complicated matters to a considerable extent and resulted in some trouble and delay in moving lengthwise of the track which was, of course, at right angles to the movement of the tractor and slip.

The tractor and operator charge was $1.50 an hour; common labor charge, 40c an hour. An average of 12 hr. was required to move 250 tons of material, making the ton cost $0.11. This amount was one cent more than for the previous method.

3. In this method, a line of 2½-in. fire hose was used with a 1⅛-in. nozzle working with hydrant water at a pressure of 55 lb. per sq. in. The nozzle consumption was figured at 125 g.p.m. Three men were required; two of whom worked on the nozzle at a time, the third man taking care of the back hose and changing off with the nozzle men occasionally.

With this method, and after some experimenting, it was found that 62 cubic yards of material could be moved per hour. At that rate the entire day's production could be moved in slightly over four hours.

For this method the cost was figured as follows: Water consumption per ton of material—121 gal. or 16.1 cu. ft. Water cost at $0.40 per 1,000 cu. ft., amounted to $0.0065 per ton;—the labor cost came to 0.013 per ton, making the total cost per ton average $0.0195, which was less than one-fifth of the cost of handling entirely by man power and shovels.

It was interesting to observe the water application. The first trial was a dismal failure. Hundreds of cubic feet of water were used with very little effect on the sand movement. The first method was to apply the stream over the surface of the pile bringing down a wide area of material on a uniform level.

The consequences were that most of the material was washed up hill. It was estimated that less than a fourth of the material was moved per thousand gallons of water applied.

Next, we tried the experiment of slicing the pile in two, taking the forward side in the first swath and then returning for the back part on the second swath. This method was better than the first, but there was still the tendency to wash up hill on the back part of the pile.

Another experiment was to cut a deep ditch through the pile and then wash the sand down from the sides into the ditch. This procedure proved very successful as the tail water tended to carry away the loose sand, and was therefore utilized, whereas, in the former methods the tail water was practically lost.

Finally, the method adopted and the one bringing the cost down to the low point noted, consisted in cutting the ridge or long pile of sand into well-defined notches.

Each notch was extended downward and out to the edge of the bank, forming deep ditches for the sand to flow down and using the tail water to its maximum capacity in keeping the ditch clear. The sand was kept in suspension the full distance of the ditch and deposited over the bank.

Anyone having a sand-handling problem such as this will profit materially by analyzing the action between the water and the material. A study of the stream will indicate the most economical application.

Waterloo, Iowa. H. C. CHARLES.

Causes of Unequal Current Division Among Brushes

WITH both d.c. motors and generators, it is important that the current be divided equally among the different brush arms, and among all the brushes on each arm. In practice this condition is not always secured; the current may divide unequally among the different brush arms of the same polarity owing to unequal resistance in the leads connecting the arms. Such a condition is very likely to occur when the conductors connecting the arms are of strip copper; loose bolts or poorly-made joints will greatly increase the resistance and, therefore, alter the current division among the arms.

It is also important that the resistance of these conductors be kept low; therefore, conductors of ample capacity should always be used. Unequal division of current among the different brushes on the same arm may be caused by different resistances of the brushes. Various causes may produce this condition; one of these is using brushes of different grades on the same machine. The brushes used on any machine should be of the same grade and resistance throughout.

If any of the brushes become copper-plated on their working faces their resistance will be altered; therefore, if there is any tendency to pick up copper the brush faces should be frequently cleaned and the cause traced and remedied.

Lubricated brushes, in which a lubricant is incorporated during manufacture, often change resistance with increasing age. Improper bedding of brushes will also cause them to have a higher resistance than the others.

A rough check of current distribution among the brushes can easily be made by feeling the brushes and their connecting pigtails after a long run on a heavy load. If some of the brushes are hotter than the others, the indication is that these brushes are carrying more than their share of the current and the cause should be investigated.

Another possible cause of trouble lies in the flexible connections to the brushes; if these are poorly made, or if some of the flexible strands have been broken, the resistance will be greatly increased and will result in overheating. Overheating of brushes is a serious matter. The expansion due to overheating may cause brushes to stick in their holders, which will result in serious sparking whose real cause may be overlooked.

Brighton, England. W. E. WARNER.

LOW CRANE MAINTENANCE, CONTINUOUS OPERATION—

The result of triple inspection

By W. D. BRISTOW

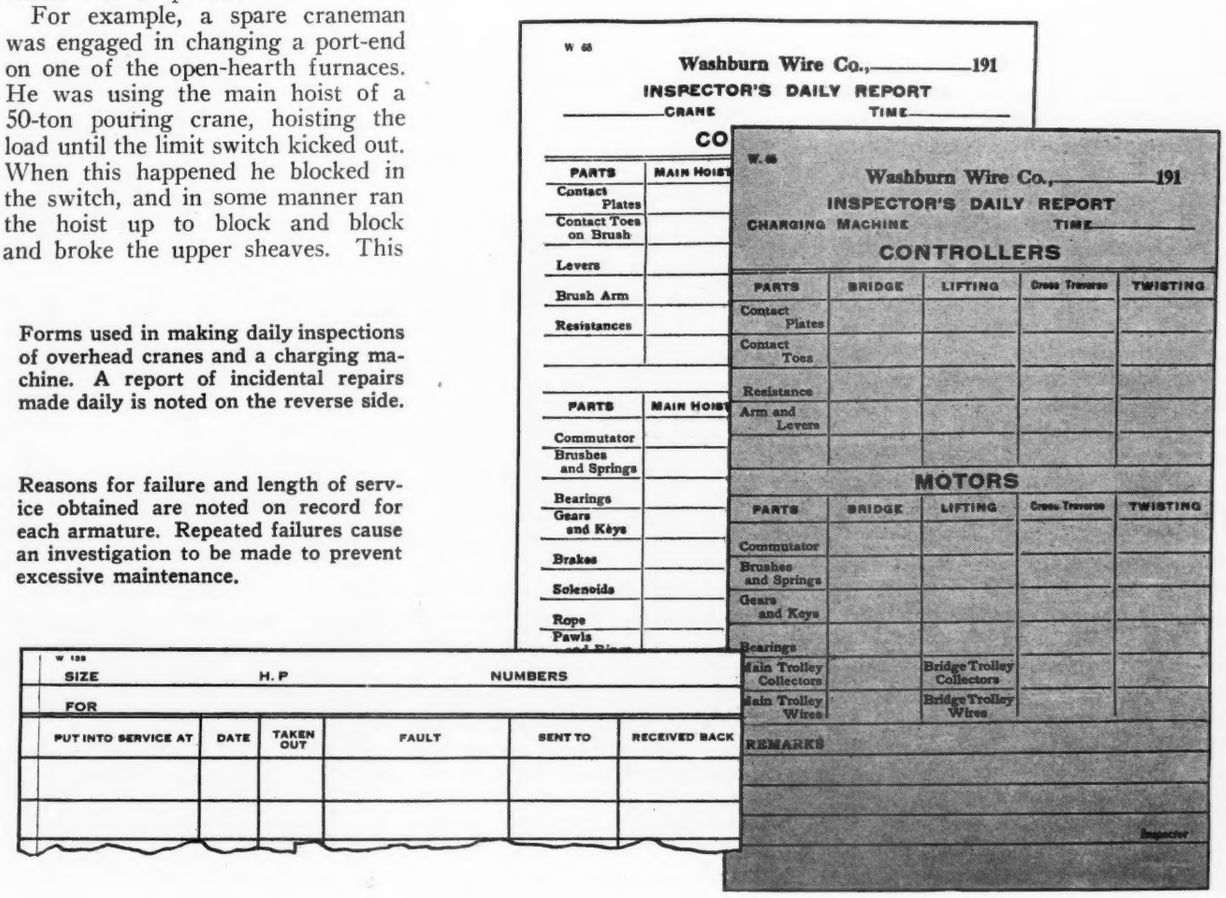
Chief Electrician
Washburn Wire Company
Phillipsdale, R. I.

OVERHEAD traveling cranes, whether new or old, when operating on a 24-hr. day, 6-day week schedule, require rigid and careful inspection to keep them in continuous operation. There are some old-type cranes in our plant, and we use a system of inspection which we find works out very nicely and economically in so far as maintenance is concerned, in that it has been the means of discovering in time some defects which might have caused serious damage and a considerable loss of production.

For example, a spare craneman was engaged in changing a port-end on one of the open-hearth furnaces. He was using the main hoist of a 50-ton pouring crane, hoisting the load until the limit switch kicked out. When this happened he blocked in the switch, and in some manner ran the hoist up to block and block and broke the upper sheaves. This operator went away and did not report the damage he had done, but the crane inspector discovered the broken sheaves on his trip to the crane, which, luckily, was before pouring time.

Complete electrical and mechanical inspection of the cranes is taken care of daily by a crane inspector, who has seven cranes and one high-type, open-hearth charging machine under his supervision. He has Form W66 to fill out for the inspection of each crane, and Form W65 for the charging machine.

On his daily routine the inspector starts in at the cab, checking the controllers, limit switch, contactors, etc., works up from there to the traverse, and finishes the inspection



W 65

Washburn Wire Co.,_____191

INSPECTOR'S DAILY REPORT

_____CRANE TIME_____

PARTS	MAIN HOIST
Contact Plates	
Contact Toes on Brush	
Levers	
Brush Arm	
Resistances	

PARTS	MAIN HOIST
Commutator	
Brushes and Springs	
Bearings	
Gears and Keys	
Brakes	
Solenoids	
Rope	
Pawls	

W. 66

Washburn Wire Co.,_____191

INSPECTOR'S DAILY REPORT

CHARGING MACHINE TIME_____

CONTROLLERS

PARTS	BRIDGE	LIFTING	Cross Traverse	TWISTING
Contact Plates				
Contact Toes				
Resistance				
Arm and Levers				

MOTORS

PARTS	BRIDGE	LIFTING	Cross Traverse	TWISTING
Commutator				
Brushes and Springs				
Gears and Keys				
Bearings				
Main Trolley Collectors		Bridge Trolley Collectors		
Main Trolley Wires		Bridge Trolley Wires		

REMARKS

Inspector

W 139

SIZE H. P NUMBERS

FOR

PUT INTO SERVICE AT	DATE	TAKEN OUT	FAULT	SENT TO	RECEIVED BACK

Forms used in making daily inspections of overhead cranes and a charging machine. A report of incidental repairs made daily is noted on the reverse side.

Reasons for failure and length of service obtained are noted on record for each armature. Repeated failures cause an investigation to be made to prevent excessive maintenance.

WASHBURN WIRE CO.

WEEKLY MOTOR INSPECTION REPORT

STEEL MILL CRANE INSPECTOR

WEEK ENDING 19

		ARMATURE	FIELD	COMM.	BEARINGS	BRUSHES	STARTER	ROPE
	NO. 1 WASTE HEAT 10 HP							
	NO. 2 WASTE HEAT 10 HP							
	NO. 3 WASTE HEAT 10 HP							

101

-25 Ton Crane #441-

12-1-28- New traverse trolley wires

12-7-28-Replace broken A.H. pawl bracket

12-9-28- 2 new A.H. motor brushes

12-10-28-Replace broken traverse motor pinion.

Form W-180

WASHBURN WIRE COMPANY _____ 195

INSPECTOR'S REPORT.

_____ CRANE TIME _____

—BEARINGS—

—BRIDGE—

MOTOR-FRONT
MOTOR-REAR
MOTOR GEAR BRACKET
MOTOR SHAFT PINION
DRIVE SHAFT BRACKETS
DRIVE WHEEL-LEFT
DRIVE WHEEL-RIGHT
TRAILER WHEEL-LEFT
TRAILER WHEEL-RIGHT

—MAIN HOIST—

MOTOR-REAR
MOTOR FRONT
MOTOR PINION BRACKET
MOTOR GEAR BRACKET
BRAKE SHAFT BRACKET
INT. PINION BRACKET-REAR
INT. PINION BRACKET-FRONT
DRUM PINION SHAFT-REAR
DRUM PINION SHAFT-FRONT
DRUM SHAFT BUSHING

—AUXILIARY HOIST—

MOTOR-REAR
MOTOR-FRONT
DRUM PINION SHAFT-REAR
DRUM PINION SHAFT-FRONT
INT. PINION SHAFT-REAR
INT. PINION SHAFT-FRONT
MOTOR GEAR BRACKET
MOTOR PINION BRACKET

—TRAVERSE—

MOTOR-REAR
MOTOR-FRONT
IDLER GEAR
TRAILER WHEEL-LEFT
TRAILER WHEEL-RIGHT
TRAILER WHEEL-OUT-BOARD
DRIVE WHEEL-LEFT
DRIVE WHEEL-RIGHT

_____ INSPECTOR

Forms used by the motor inspector in going over all plant motors, including those on cranes and charging machine.

Facsimile of page from a crane book, which carries a record of the life of equipment utilized in crane maintenance.

Bearing wear is determined weekly by measurement with feeler gages which are inserted between the shaft and bearing. The wear is recorded to provide a means of telling when it is necessary to replace bearings.

with the bridge equipment. It is his personal duty to run each motion, and then have the crane operator do likewise while he observes the running condition. Coincident with this daily inspection, the crane inspector makes all minor repairs, looking after short brushes, worn slide collectors, burnt contact plates on controllers, etc. After making a record of these repairs on the reverse side of the inspection report, he sends it to the chief electrician.

A special book for each crane is kept in the chief electrician's office, into which all these minor repairs are copied, thus creating a record of the life of brushes, contact plates, and so on, for each crane.

Every Saturday morning, the motor inspector checks all motors throughout the plant, including crane motors. This inspection checks the work of the crane inspector in so far as motors are concerned. The motor inspector fills out Forms W141, W141A, W142, and W142A. Bearings on all cranes are inspected weekly. The man charged with this responsibility also does the greasing and cleaning of the cranes, which are completely equipped for high-pressure lubrication. The lubricant is applied daily by this man, who is entirely responsible for the continued operation of the equipment.

On his last trip to a crane on Saturday he measures the wear of the different bearings. For this work he is provided with feeler gages of various lengths, that are graduated in thousandths of inches. By inserting a gage between the shaft and the bearing he determines the amount of wear, and records it on Form W180.

These forms, when turned over to the chief electrician, enable him to see at a glance the condition of the bearings on any crane. One can readily observe with this system of crane inspection that there are three men looking over each crane, which assures those in charge that if there is any defective part one of these men will surely find it.

It is essential that a large inventory of replacement parts be maintained, because the plant is situated far from the crane manufacturer. When gears are ready to be replaced, we install standard stock gears made

by a gear manufacturer located nearby, for the reason that they can be purchased much cheaper and can be delivered to our plant on the same day as ordered, thus enabling us to reduce the inventory.

On each crane there is a small box in which are kept spare fuses and contact plates for the controller arm brushes. Also, there are three spare traverse trolley wires completely made up to length with the strain insulators attached. As this spare material is used, it is immediately replaced. This system saves many precious minutes in the inactive time of the crane, and many unnecessary steps for the inspector.

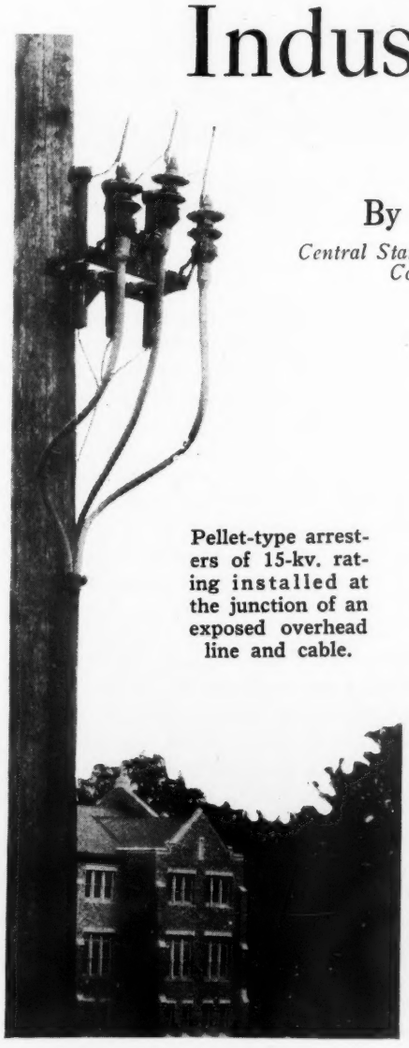
Spare bridge motor-drive shafts, and traverse drive shafts are kept in stock with motor pinions and, in the case of bridge shafts, brake drums are already installed. Spare armature assemblies are made up with the rear yoke, bearing, and pinion, and brake drums where needed.

A complete record of the time armatures remain in service and the reasons for taking them out are kept on Form W135. All armature repairs and rewinding are done in the electrical shop, using factory-made coils wherever possible.

All repair work, such as overhauling load brakes, relining band brakes, turning commutators, making up spare trolley wires, overhauling controller arms, making driveshafts, etc., is done by the night maintenance man. Electrical and mechanical repair work on all cranes, motors, and other plant electrical equipment is made by the electrical department personnel.

By referring to the inspection forms for the cranes and other equipment in the plant, the impression is given that it would take quite a force to keep this plant running but, on the contrary, everything has been arranged so that a force of four men on the day shift and one man at night handle all the work very easily and satisfactorily.

Lightning Protection for Industrial Substations



Pellet-type arresters of 15-kv. rating installed at the junction of an exposed overhead line and cable.

By H. M. TOWNE

Central Station Department, General Electric Company, Pittsfield, Mass.

SOME of the characteristics of, and the effects produced by, lightning were discussed in a previous article in the June issue. The next step is to apply the information available, much of which has been obtained comparatively recently, to the protection of substation and other equipment.

The protective performance of a lightning arrester is best defined by studying the arrester under impulse conditions with the cathode-ray oscillograph. Tests on arresters at commercial frequencies will disclose little concerning the arrester's ability to discharge large impulse currents and limit the impulse voltage to a safe value. In the laboratory and on transmission lines, tests of arresters by means of portable lightning generators have resulted in an exacting expectancy for arrester performance.

The impulse voltage allowed by a lightning arrester depends upon the relation of the arrester resistance plus the ground resistance to the surge impedance of the circuit at the point of installation. The lower the discharge-path resistance, the better the protective performance. In general, the impulse voltage allowed by an arrester of a given type or design will increase directly with an increase in arresting rating. Hence, the impulse protective performance of an arrester for almost any rating can be quite accurately predicted from a knowledge of the impulse behavior of that type of arrester, of any given rating.

The valve action, or ability of the arrester to prevent or interrupt the flow of system follow-current after the lightning discharge, is not defined by cathode-ray oscillograms showing the impulse performance. All arresters permit some system follow-current after the lightning discharge and it is essential only that the magnitude and duration of this follow current be neither harmful to the arrester or to the electric circuit. The only purpose of the arrester is to limit the lightning potentials, and this impulse protective performance

should be the chief criterion of the arrester's efficiency. After an arrester discharges the lightning impulse, it must harmlessly restore itself to a non-conducting condition, and it is immaterial whether this action is attended by a follow current of 1 or 10 amp. for a fraction of a half-cycle of the system voltage.

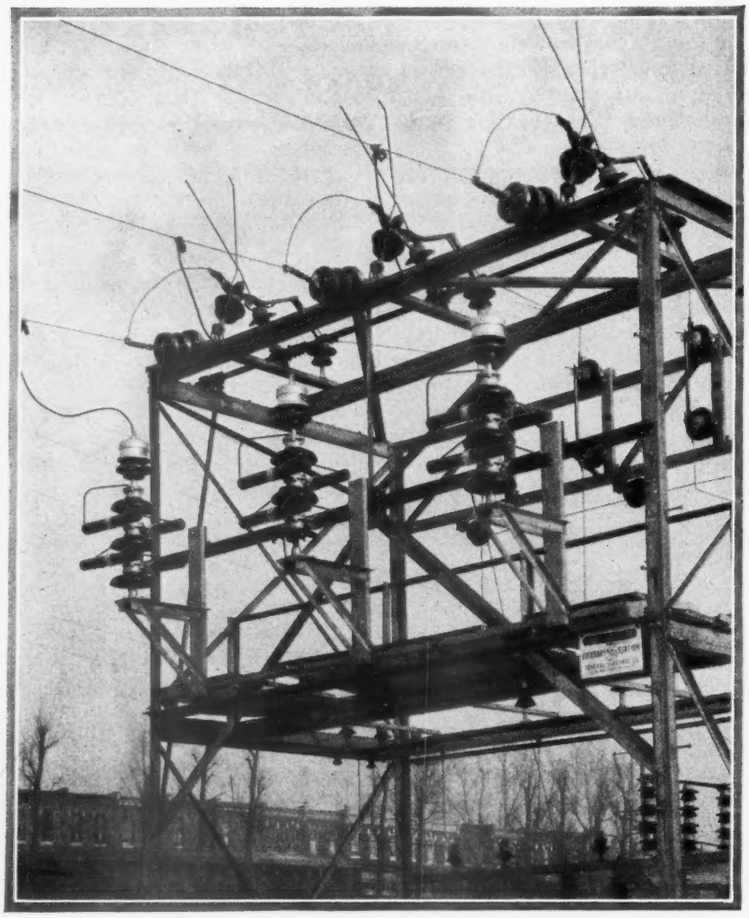
Industrial plants frequently have the problem of protecting generators, motors, or other rotary equipment directly connected to exposed overhead lines. On account of slot windings, it is not possible to obtain the same insulation strength in generators and motors as in transformers or other stationary equipment. Furthermore, generators and motors operate with dry insulation, having no oil dielectric. Thus, their protection warrants special consideration when they are directly connected to overhead lines without intervening transformers.

Obviously, the greatest security against lightning failure of generators or motors is had when they are isolated from exposed lines by transformers. The transformer, with its oil insulation, relative freedom from moisture, and reinforced end-turn insulation presents a much higher factor of safety in impulse strength.

Where no intervening transformers are present, it is desirable to treat the protection of the generators or motors as a special problem, warranting something better than the usual impulse protective performance of standard arresters. The maximum possible voltage of the generator or motor should be carefully estimated and the arrester designed for just slightly above this voltage.

Further improvement in protective performance can be had by incorporating with the arrester a shunt capacitor connected directly across the arrester line and ground terminals. This arrester-capacitor combination permits a degree of protection which is more commensurate with the impulse strength of rotary equipment. The capacitor slops off the impulse wave front, thus reducing the turn-to-turn stresses in the generator winding, and also produces a somewhat lower impulse characteristic for the arrester itself. The arrester-capacitor unit should be installed very close to the generator or motor to be protected.

If the neutral of the generator or motor is non-grounded, it may be desirable to introduce some form of discharge path between the neutral point and ground, to prevent the impulses that enter the winding from reflecting to double value at the neutral point.



Installation of 33-kv., pellet-type arresters on a small substation structure. The choice between station-type and the smaller line-type arrester is a matter of economy.

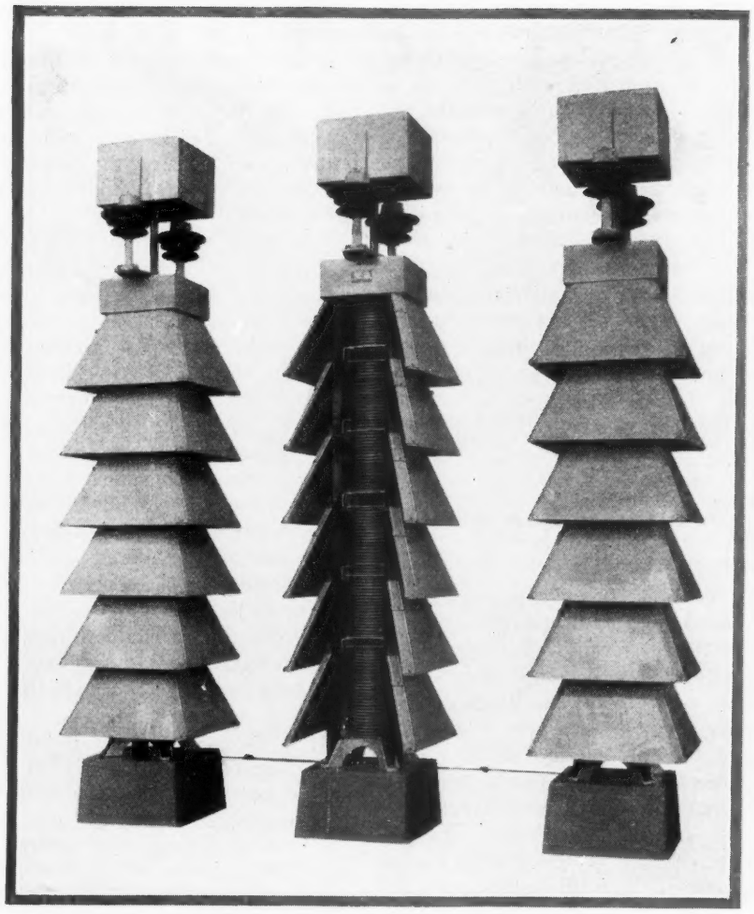
The choice between station-type and the smaller and less expensive line-type arresters for industrial substation application is a matter of economics and the importance of service continuity. For the ordinary class of lighting surges, both arresters will limit the potentials to about the same value. Station-type arresters, however, have a greater cross-section of discharge path and greater endurance to a prolonged succession of discharges, or extremely severe discharges. Some operating conditions that would result in failure of the line-type of arrester would not damage the station-type design.

Under arcing-ground conditions, which impose a severe duty on the arrester, causing two phases of the arrester to discharge more or less continuously until the ground fault is eliminated, the station-type arrester is decidedly less likely to be injured. However, neither type of arrester is designed to withstand such discharge conditions continuously.

The cost of the station-type arrester is about three or four times that of the line-type arrester for a given voltage rating. The added premium for protection will generally be well warranted, particularly where the maximum security is imperative.

Industrial plants often have relatively short but exposed feeders, or perhaps secondary circuits, extending throughout the plant. Too frequently these are considered as not requiring protection because of their limited length. The importance of service continuity of all plant circuits warrants careful consideration of the exposure, and the need for lightning arresters. Inexpensive line-type arresters will generally suffice, and should be located where the circuits leave or enter buildings, to prevent dangerous potentials from reaching apparatus terminals.

Lightning frequently causes service interruptions by blowing fuses at substations, and it is often sup-



A typical three-phase, oxide-film, station-type lightning arrester for a 33-kv. circuit. The shields have been removed from the front on one phase to show the assembly of oxide-film cells.

posed to be due to the lightning or transient current passing through them. Such is rarely the case. The time duration of lightning transients is so short (a matter of microseconds) that several thousand amperes may be required to blow a 20-amp. fuse. Transient currents of sufficient magnitude to affect the fuses are improbable except in the case of direct strokes at or close to the station.

More often flashovers to ground of the low-tension feeders or secondary circuits develop momentary short circuits of the system voltage, which cause fuse operation. Frequent fuse blowing is usually direct evidence of inadequate protection against lightning flashovers. A flashover at a remote point of a feeder or secondary line may cause the main, high-tension fuse to blow, and this action may be incorrectly attributed to inadequate protection of the high-tension side.

Lightning flashovers that result in blown fuses will usually be manifested by arc scars or pits at the point of flashover. A careful survey of the secondary circuits for weak points in the insulation, or probable points of flashover, and a scrutiny of apparatus terminals, bushings, or leads for arc scars, may disclose the offending point. If it is found that high-tension fuse blowing is due to lightning flashovers on the high-tension side of transformers, the indication is that the insulation is weak, that the arresters are not sufficiently effective, or that their location and method of grounding may be improved.

In applying lightning arresters most effectively, we must recognize the extremely transient or steep-wave front nature of lightning impulses. With these impulses the voltage to ground at one point of the circuit may be greatly different from the voltage to ground a short distance away. The hyperbolic volt-time breakdown characteristic of apparatus insulation, whereby the voltage required to cause flashover or failure becomes lower with increased time of voltage application, must also be recognized. These considerations and practical experience dictate that in all arrester applications the arrester should be located as closely as possible to the apparatus to be protected.

The protective efficiency of any arrester installation is greatly influenced by the ground resistance between the arrester and earth. A ground resistance of 5 ohms or less should be had with station-type arresters, and not more than 15 ohms for line-type arresters. The arrester ground should be located directly at the point of arrester installation.

Where high-resistance soil is encountered 50 or 75 lb. of ordinary cattle or ice cream salt applied around the driven electrodes will usually reduce the resistance of the ground from 50 to 85 per cent.

Although each arrester at the station should have its one ground connection, close to the arrester, this ground may be bussed together with other grounds for earthing station equipment. By interconnecting the grounds at the station, the net combined resistance to earth will be lower and the whole station ground for all purposes will be more reliable; moreover, hazard to life from dangerous potential gradients between the various individual ground electrodes will be avoided. However, in very small industrial substations having a grounding system of limited extent, particularly where very low resistance values cannot be obtained, it may be desirable to keep the high-tension arrester and apparatus ground isolated from the low-tension arrester or neutral ground.

Overhead ground wires on the transmission lines should be connected into the station ground system.

The choke coil is no longer recommended as a lightning protective device. Exacting tests have shown that such coils do not aid the performance of modern arresters, nor reduce the stress on the transformer or other apparatus. Moreover, under some conditions of apparatus combinations and wave fronts, a choke coil may even be detrimental.

Adequate protection of industrial substations and electric service against lightning involves careful consideration of numerous factors. All of these must be properly coordinated into a straightforward and logical scheme of protection, as serious neglect of any one factor may

greatly diminish the protective efficiency. To gain the desired protection necessitates the location of the arrester very close to the apparatus to be protected and requires effective, low-resistance grounds, preferably connected in with the apparatus frames and substation ground.

Secondary circuits should never be slighted by the omission of arresters when they present any exposure at all to lightning. Substation, line, and apparatus insulation should be carefully selected for either high-tension or low-tension circuits, and the insulation, particularly in substations, should be kept at its maximum strength by periodic removal of dust deposits or accumulations.

Over-insulation in the substation should be ventured with care, as it necessarily renders the apparatus insulation relatively weak: a flashover of apparatus or failure of its major insulation is obviously more serious than the mere flashover of dead-end, bus, or switch insulators.

Absolute immunity from lightning troubles cannot be realized at present, but an excellent approach to immunity and great economies in operation can be attained by proper application of the principles underlying the lightning protective problem.

This Month's Cover

THE plant of the Atwater Kent Manufacturing Company, maker of radio apparatus, is shown on the front cover. The organization is so arranged that the plant engineer reports directly to the president, as do the four production managers, the sales department, and the office management.

Included among the details of the function of plant engineering are the maintenance of buildings; layout and design of new construction; purchase and maintenance of electrical equipment; purchase and maintenance of all mechanical equipment except production machines; purchase and maintenance of all steam equipment. Also included are all details of lighting, painting, heating, and plant protection.

Approximately 300 employees are engaged in plant engineering and maintenance work in the four subdepartments known as General Follow Up, Electrical, Drafting, Cleaning and Laboring.

Under the two roofs, which are of saw-tooth construction, there are 1,365,525 sq. ft. of floor space, five miles of belt conveyors, three miles of chain conveyors, 1,800 miles of electric wiring, 50,000 sq. ft. of belting, six elevators, 1,249 electric motors. The connected motor horsepower is 4,095. In May, 1929, there were 11,500 employees.

Added to the plant since taking the photograph from which the cover illustration was made is a power plant with boilers running seven stories high. The building is of brick, steel, and concrete construction. It was designed primarily as a steam heating unit but arrangements have been made whereby a considerable portion of the electric current required for factory purposes will be generated. Steam for the molding department will be supplied from this plant. The 750-kw. turbine generator, which acts as a reducing valve for the heating steam and at the same time furnishes a considerable part of the electric current, is a unique piece of apparatus. The control equipment is tied in with the operations of the utility company which furnishes the factory with the remainder of its current.

It will be noticed that a bridge joining the two buildings was being constructed when the photograph was taken. This bridge has since been completed.

Flame-Proofed Wood Tested

ACCORDING to a news release, Columbia University, through Prof. Albin H. Beyer of the testing laboratories of that institution, gave its approval to the latest method of flame-proofing wood when laboratory tests of the process were made recently at the plant of Henry Klein and Company, Elmhurst, L. I., the inventors.

The release states that a 2-in. door of the wood held back smoke and flames six times as long as did a metal-covered door carrying the label of the Fire Underwriters' Laboratories. The protracted immunity of wood to fire is accomplished by impregnating lumber under high pressure with a chemical preparation. When attacked by fire, this chemical throws off a gas which kills fire on the same principle as a fire extinguisher.

In each row of cells of the wood are deposited minute chemical crystals. As one row of cells comes in contact with the flames it offers temporary resistance to the fire and is in turn supported by the millions of rows of cells behind it.

The metal-covered and the wooden doors were set in the sides of a large furnace, the flames sweeping their interior faces. The metal-covered door quickly became untouchably hot, passing 120 deg. F. in about three minutes, and in fifteen minutes passing 660 deg. The wood door's exterior reached 100 deg. after thirty minutes and at the end of forty-five minutes was still under 150 deg. It did not go over 200 deg. at any time.

In the metal-covered door, after ten minutes smoke poured through the joints in heavy clouds, and flames appeared. The wooden door held back both smoke and flames for a full hour until it was less than ⅛ in. thick.

It is claimed that the definite fire resistance of the wood is attained by the proper control of the impregnation of the chemicals.

Salvage Days Promote Shop Betterment

OPEN the cupboards, bench drawers, look into the corners in any department of the shop. What does one find? A collection of odds and ends. There are pieces of wood, steel, bits of this and that stored away with the thought in mind that sooner or later someone is going to have need for just that particular piece of material.

Suppose there are 1,000 employees in a given plant and each one hoards 10 lb. of material. Ten thousand pounds, or five tons of junk hoarded away is a lot of material.

Assuming that some of this material has a value above its scrap value then the right place for it is in the stock room; otherwise the answer is, stop building cupboards, chests of drawers, benches with drawers included. Designate salvage days when the scrap material in all departments is to be collected and salvaged, either as so much scrap, or material returned to stock for future use. The matter of cleanliness throughout the plant owing to the elimination of this material is not to be underestimated.

H. C. CHARLES.

Waterloo, Iowa.

QUESTIONS *and* ANSWERS BY READERS

How Make Paint Adhere to Galvanized Iron?

We have experienced considerable trouble in getting paint to adhere to so-called tinplate and galvanized, corrugated iron that are exposed to the weather. When new material is painted it looks all right at first, but before long the paint starts to peel off in places, exposing the bar metal. I shall appreciate it if readers will tell me what kind of priming coat, or method of treatment beforehand. should be used in order to obtain a good, permanent finish. J. G. R.

Buffalo, N. Y.

Is Two-Parallel Star Better Than a Single-Delta Connection?

We have a 440-volt motor connected single star, which we want to change so that it will operate on 220 volts.

Would it be better to change the winding to a single-delta or a two-parallel star connection? Please explain why the one connection is preferred. M. R. T.

Dayton, Ohio.

Changing Shunt Motor to Compound

I have a 3-hp., d.c., shunt-wound, four-pole, Type CM, Crocker-Wheeler motor that I wish to change to the compound-wound type. Can some reader tell me what size of wire and how many turns I should use in the shunt and series windings? G. W. W.

Clifton Heights, Pa

Calculating Current in Neutral of Three-Phase, Four-Wire System

With an ammeter cut into each phase of a three-phase, four-wire system I obtained the following readings: Phase A, 50 amp.; phase B, 40 amp.; phase C, 35 amp. I should like to know the magnitude of the current flowing in the neutral wire, and wish that someone would give me a formula by which I can calculate the current flow in the neutral. Will the power factor of the load have any effect on the current carried by the neutral wire? B. J. W.

Los Angeles, Calif.

What Proportion of Oven Area Should be in Explosion Panels?

In obtaining figures on box-type enameling ovens lately, I noticed that none of the companies agreed as to the percentage of oven area that should be in explosion panels. As this seems to be a most important factor I recommended to our purchasing department that the one having the largest area in explosion panels be given preferences. Although this is playing safe it is not good engineering as even the one with the greatest area may not be safe. If anyone has any test data on this subject or knows of any accepted standards I would appreciae hearing from him.

I. M. G.

Tcledo, Ohio.

REFERRING to the question by I. M. G., The Associated Factory Mutual Fire Insurance Company recommends a minimum of 1 sq. ft. of explosion vent for every 15 cu. ft. of oven volume. We believe that this is a good minimum figure, but the important thing is to see that the explosion vent is so light and so easily operated that no considerable back pressure will be set up.

Area is not so important as it would seem to be if the construction of the explosion vents were not properly taken care of. The nature of the vapors encountered in the oven should be taken into consideration, and wherever possible larger areas than those given above should be used.

E. B. CRAWFORD.

Vice-Pres. and Treasurer
The Crawford Oven Company
New Haven, Conn.

REPLYING to I. M. G., the inspection department of the Associated Factory Mutual Fire Insurance Companies, Boston, Mass., in their authoritative book on regulations covering japaning and enameling ovens gives this information:

"The minimum explosion vent area should be 1 sq. ft. for every 15 cu. ft. of oven body."

It further states that this ratio will not prevent destructive effects if the oven should become filled with strongly explosive mixtures, or if the vent should have too much inertia. Consequently, every effort should be made to provide generous explosion vents and to have these vents of such light weight that they will move readily and relieve pressure at the outset.

Perhaps I. M. G. will want to write for this booklet, which gives other information in regard to the application and drying of japans and enamels.

Our standard procedure in regard to explosion vents is to allow all of the roof panels of the oven to be loose, so that instead of having 1 sq. ft. for every 15 cu. ft. of oven volume, we have many times this area which will be lifted out of place in case of an explosion.

H. L. GRAPP.

Sales Manager
Despatch Oven Company
Minneapolis, Minn.

What Preservative to Protect Wood from Decay?

In some of our buildings the temperature is quite high and our processes make it necessary to maintain a high degree of humidity, by the use of humidifiers. This combination of warmth and moisture causes very rapid decay of wooden beams and other parts, and makes frequent replacement necessary. Painting does not stop the trouble, and treatment of the wood with some preservative seems to be required. I shall appreciate it if readers who have had similar experience will tell me what kind of preservative they have found most effective, and how it should be applied.

M. J. W.

Atlanta, Ga.

AS mentioned by M. J. W., decay of the wooden structural members of a building where high temperatures and moisture prevail is caused by living organisms, such as bacteria and fungi.

The best preservatives that I know of are creosote and bichloride of zinc. Presumably the amount of timber to be treated would not warrant M. J. W. in purchasing the necessary tanks and other equipment for doing the work properly; so the best thing to do is to purchase lumber treated with one of these preservatives from some concern which is willing to guarantee that their product has been properly impregnated.

Creosoting is the cheaper and is good enough to resist moisture and ordinary temperatures; however, the high temperatures in M. J. W.'s plant may make the bichloride of zinc treatment the

ANSWERS *to* QUESTIONS

more economical in the long run. I would suggest that on the first replacement, wood treated with bichloride of zinc be used exclusively, except for a few creosoted timbers or other parts that can be used as a gage to measure the relative life of the two treatments under the same conditions.

These two preservatives act merely to poison the wood so that the organisms producing decay cannot subsist on it.

Denver, Colo. CARL A. WAGNER.

IN answer to M. J. W.'s question, I would suggest that he paint the timbers thoroughly with Turner roofing paint. It should be applied rather hot, and three coats will be necessary.

Repaint them whenever the wood starts to show through the paint; better still, just before it begins to show. He will soon learn by experience just when repainting is needed.

This paint is made by the Turner Roofing Company, Ada, Ohio. It is not an expensive paint, and I have found that timber will last practically indefinitely if kept covered with it, regardless of moisture or temperature.

Chief Engineer M. B. KRAMER.
El Paso Milling Company, Ltd.
El Paso, Texas.

What Causes Heating of These Cables?

I wish someone would tell me why the cables on our electric bread-baking oven heat up. From the 800-amp. oil circuit breaker two 500 000-circ. mil., varnished cambric cables for each of the three phases pass through a 5 ft. 5 in. length of iron conduit. The cables then run open for a short distance and finally enter two 3-in. iron conduits spaced on 6-in. centers running to the oven, which is about 800 ft. away. At the oven the two cables for each phase are connected to a common bus. We were careful to keep the proper phase relation, so that each conduit contains one A-, one B-, and one C-phase cable. The load varies from 600 to 800 amp., and when it is on, the cables heat up badly and the two conduits become very warm for their entire length, although not exposed to external heat. I believe that if the cables had been run in one conduit, there would have been no appreciable amount of heating.

Will readers let me know whether this view is correct? If not, what causes this heating?

B. C.

Somerville, Mass

JUDGING from the data given in B. C.'s question, there are no definite reasons why these cables should heat appreciably. The question does not state what the room or surrounding temperature is in which the cables have to operate. The writer has had considerable trouble from this source, where the room temperature was as high as 150 deg. F. in power station installations.

The question does not make any statement concerning the balance of the current in the circuit; this is a possible source of trouble and will cause the local heating referred to. It will be advisable to test the current in each cable at the oven, using a split-core transformer or other means. The possibility of the current being unbalanced in the separate conductors seems the most likely source of the trouble, as nearly as can be judged from the information given. Putting all six cables in a single conduit would undoubtedly help to improve conditions as it would tend to neutralize the current unbalance, if any exists.

C. O. VON DANNENBERG.
New York, N. Y.

REGARDING the question asked by B. C. I will say that, having had a similar experience, I think he has expressed the solution of his trouble in the last two paragraphs of his question.

To run the line feeding his oven in one conduit, or to run the line on wire racks in the open, either within the building or on the outside would, I feel, overcome his difficulty.

In my opinion the heating is caused by the transformer effect of this circuit passing through metal conduit when all the wires are not within one and the same conduit.

Electrical Engineer A. C. BARKER.
W. S. Libbey Company
Lewiston, Me.

Using Rubber Hose in Place of Conduit

In our plant we have used several thousand feet of rubber hose, in place of conduit. While the basement walls and engine blocks were being built the hose was laid in the concrete. All necessary wires were pulled into the hose before it was put down.

I wonder if any of our readers have tried this scheme, or can tell me whether this installation will be satisfactory. How long should the rubber hose last? Will it tend to draw moisture?

J. M.

Palmer, Neb.

I HAVE used rubber hose for the purpose indicated by J. M. in a great many instances and so far as durability and life are concerned, I can say that one particular run has been in service for more than ten years. Local conditions and the quality of the hose will have an important bearing on this point.

There is today a patented method which has been applied to underground systems, as well as to interior work, in which the concrete is first poured around the hose and after a period of setting the hose is pulled out, leaving a very smooth opening. This method is particularly applicable where conduit runs are very crooked and congested. C. O. VON DANNENBERG.
New York, N. Y.

USE of rubber hose imbedded in concrete, as J. M. suggests, should not be objectionable and so far as longevity is concerned, the conditions would be ideal, I should think. Rubber is usually under the best conditions for long life when it is not exposed to light or heat, and moisture is better than excessive dryness for preserving it.

Perhaps J. M. is not aware that much work has been done in New York City with rubber mandrels cast into the concrete and then withdrawn as the work progresses. This is the basis of a patented system used in some of the largest power stations in that city. JOHN S. ISDALE.
Plant Engineer
International Silver Company, Factory K,
Meriden, Conn.

Avoiding Sagging of Belt on Vertical Drives

We are well aware of the fact that vertical belt drives are often troublesome, but the conditions encountered in some rearrangements that are being made will necessitate the use of several drives that will be approximately vertical. We are using leather belts, and the driving motors range from 5- to 20-hp. rating. Will some readers tell me what is the smallest angle from the vertical that will overcome the sagging of the belt away from the bottom pulley? If we can obtain this angle we may be able to avoid, or lessen, any trouble.

Youngstown, Ohio. **L. A. M.**

REPLYING to L. A. M., I would strongly advise that where vertical belt drives are being installed, a weighted idler be used in each case on the slack side of the drive.

If the idler is designed so as to increase the arc of belt contact on the smaller pulley, a much more efficient drive will result. It will usually permit the use of a somewhat narrower belt than would be the case if no idler were used.

Use of a spliced belt is to be recommended in this case, as the idler will take up the slack and stretch for a considerable period, so that possibly only one resplicing of the belt will be necessary. If the drives can be planned to operate at a slight angle from the vertical there will be a further gain. In this case the angle from the vertical should, of course, be such that the slack side of the belt will be on top.

Maintenance Engineer J. W. CURRAN.
Boston Gear Works, Inc.
Norfolk Downs, Mass.

Voltage Changes in Motors and Generators

Changes in the operating voltage of a. c. and d. c. machines are frequently desirable, but not always practicable. Here are the governing factors.

By A. C. ROE

CHANGING conditions in the generation, use, and transmission of power, as well as the increasing use of full-voltage starting of induction motors, have made the problem of changing existing equipment to operate on, or generate a line voltage of a different value from the original rating, quite common. It is the purpose of this article to give a brief outline of the major factors that govern such changes and must be considered for each case.

No attempt will be made to detail the various reasons for changing the line voltage, nor will the details of making these changes be given. The discussion will be restricted to the major factors that enter into the problem and the procedure that is necessary to accomplish the desired results.

These data can be used to determine whether the change is desirable and what information and material to request from the original manufacturer.

Direct-Current Machines

Under this heading come series, shunt, and compound motors and generators, industrial, railway, vehicle, and mining motors, rotary converters, rotary booster converters, and other equipment operating on a fixed line voltage.

The changes required can be divided into two broad classes covering increased voltage and decreased voltage. The required increase or decrease will vary considerably.

In general, it can be stated that increasing the voltage is the more expensive and unsatisfactory change, as will be indicated by the following factors:

The voltage can be increased a small percentage without any change in the windings; the speed will increase, as will the horsepower, but commutation and heating limit the amount that the voltage can be increased.

Insulation and creepage distances are important factors and should be checked carefully when the voltage increase necessitates a change from the 600-volt class to the 1,500-volt or higher class. The increased voltage means more insulation and greater creepage distances, resulting in less copper area and a reduction in rating.

In general, increased voltage requires more turns of a smaller wire in the armature and field coils. This means, in the majority of cases, rewinding the armature and installing new field coils. If the voltage between bars becomes too high, a new commutator will be needed to suit the new winding. A complete new armature may even be required. In short, the average increased-voltage change will necessitate an expensive rebuilding.

There are a few cases where a lap winding can be changed to a wave winding, but the size of the machine and the number of poles limit this possibility.

Reducing the voltage offers more opportunity for using the existing winding, as the field coils can be connected in parallel or series parallel. The insulation and creepage distances will be satisfactory and can be reduced in some cases to permit increased copper area, thus reducing the temperature rise. However, the current-collecting or carrying capacity of the brush rigging and commutator limits the amount that the voltage can be reduced and still retain the original horsepower or kilowatt rating.

When a change from a wave to a lap winding is contemplated, provisions must be made for equalizer connections to insure good commutation at all loads.

When considering equalizer connections it must be remembered that a lap winding with or without equalizers requires a brush arm for each pole. This means that a vehicle, mining, crane, or railway motor that has a wave winding and two brush-holders cannot be changed to a lap winding with equalizers and still use only two brush-holders, as four will be needed on a four-pole motor, six on a six-pole motor, and so on.

Summarizing the preceding discussion, the major factors listed below govern any voltage change on d.c. apparatus and must be considered:

1. Number of turns in armature and field coils.
2. Size of wire in armature and field coils.
3. Type of armature winding.
4. Voltage between commutator bars.
5. Current capacity of commutator.
6. Current-collecting capacity of brush rigging.
7. Insulation at various points to ground, as between rings, turns, brush arms, brush-holders and field coils, etc.
8. Creepage distances for commutator V-rings, brush studs,

between adjacent field coils, a.c. taps, and so on.

9. Number of poles; this governs the number of combinations possible in paralleling field coils and armature windings.

10. Insulation class, as class A or class B. This feature is important when the changes made affect the rating, as anything that tends to reduce the rating will increase the temperature and necessitates class B insulation.

11. Magnetic values and relations must be kept reasonably close to the conditions existing in the original winding.

12. Voltage or speed regulation will depend on the manner in which the voltage change is accomplished.

Alternating-Current Machines

Voltage changes on a.c. machines are more common than on d.c. equipment and the majority of changes consist of reconnecting a winding from 220 to 440 volts, 110 to 220 volts, and so on. Such alterations are affected by changing the number of parallel circuits, or by changes that keep the line voltage in the class for which the machine is insulated.

The insulation on the stator coils of a.c. motors or generators can be divided into several distinct classes. In each class the insulation to ground on the coil ends, between turns, on the leads, and elsewhere will differ. Also, each voltage class requires definite mechanical clearances, such as extension of the slot section beyond the end of the core iron, distance between end brackets and coils, stub or U-type connections, and so on. These classes of insulation are:

1. 600 volts or less.
2. 1,100 volts to 2,500 volts.
3. 3,500 volts.
4. 4,500 volts.
5. 6,600 volts.
6. 11,000 volts.
7. 13,200 volts.

The voltage class thus limits the number of possible reconnections to voltages in the same class or to a voltage in a lower class. Never try to use an existing winding that is insulated for a given voltage by reconnecting it for a voltage in a higher class.

When it is desired to increase the voltage, for example, from 4,600 volts to 6,600 volts, or from 2,500 to 4,500 volts, the amount of space available for the additional insulation required on the coils and between turns will determine whether the rating will have to be reduced. The type of internal insulation used, as class A or B, will also be a deciding factor as to what rating can be had at the higher voltage. Thus, when a voltage increase is desired the characteristics of the equipment should be available to permit deciding on the final rating at the new voltage.

On a.c. motors of the wound-rotor type, the rotor winding will be satisfactory regardless of the voltage increase or decrease made in the stator windings, providing that the relations between the windings are not changed.

When reconnecting a motor from a higher to a lower voltage the cables for leads, star, and paralleling rings must be changed in the majority of cases. For example, with a change from 440 to 220 volts, the cable should be satisfactory, but a change from 440 to 110 volts will require a larger cable. A safe rule to follow is: Above the 600-volt class, increase the cable area in the same proportion that the voltage is decreased.

In the 600-volt class with a reduction from 220 to 110 volts or from 440 to 220 volts the cable should be satisfactory. Any further reduction will require a cable of larger cross-sectional area.

When the voltage decrease is from a higher to a lower class that requires less insulation, the copper losses can be reduced somewhat by rewinding. A greater copper area can be used, the mean turns per coil decreased, and the cost of the lower-voltage coils will be less than that of the high-voltage coils. Thus, lower operating cost and a new winding are the advantages gained.

Electrical Maintenance Engineer—

The plant physician

By R. H. ROGERS
Industrial Engineering Department
General Electric Company

IT IS said that a man is as old as his arteries—manufacturing plants are as old as their electrical equipment.

One writer recently tersely stated that every plant has two junk piles, one outside the walls and one inside the walls. The size of the inner junk pile can be kept down by the maintenance men whose primary business it is to keep things from happening. Only slightly less important is their function of recommending modernization for no one in the organization is in better position to see what is needed and when it is needed to hold obsolescence down to a figure that will insure a reasonably long life for the plant.

Suppose some major equipment is put in today and that it is the best procurable for the purpose—call that par or 100. Depreciation starts immediately but its progress will be slow or fast according to the diligence of the maintenance forces; to check it to a standstill is impossible. In a period of ten years its condition may be called 90 or ten below par. In the meantime that class of equipment has been improved and a competitor installs it. That equipment may well rate 140 on the old basis or 50 points better than the ten-year-old equipment that is still going strong.

Abstract of a paper presented to the Electrical Maintenance Engineers Convention at Cedar Point, Ohio, June 19, 1930.

Obsolescence

Obsolescence has gotten in its work four times as fast as depreciation. Electrical maintenance men should keep a sharp eye on this phase of plant ageing.

Electrical men connected with the industrial world are in a strategic position to foster modernization, at least to the extent of making it possible for a plant to hold its own and

in many cases keen concerted action on the part of the electrical forces has shoved an institution up among the leaders in its line.

That is the broad view to take: know what is the best, what trends are, press relentlessly for modernization, install conscientiously, and maintain intelligently.

Maintenance may be of the "main-strength" type where without question the same sort of repairs are made over and over on the same units. They are kept going, it is true, but at high cost. We are prone to become "mill-blind" unless we specifically guard against it. Shop troubles can repeat themselves until we are calloused to them and we accept the routine of making certain repairs or replacements periodically.

Intelligent maintenance implies that thought will be given to the cause of every failure which leads to maintenance expense. The unit in trouble must be studied first and if no cause is apparent the search must extend both ways from the trouble point until the cause is run down.

Study Equipment Constantly

Periodic studies should be made of electric power equipment because improvements are being made all the time by manufacturers and a type of equipment unsuited to a job five years ago may be the ideal unit today, while on the other hand the accepted standards of a few years ago are obsolete now and newly fitted out plants are being benefitted by the improved designs and higher standards of the present. Any motor or control over five years old should be coldly scrutinized for present day fitness so rapid has been electrical design progress. How is the management to know when to modernize or how, except by the suggestions of those closely in touch with things as they are and as they should be?

Don't be complacent; don't be satisfied with things as they are; competitors are not. Have ideas about improving electrical conditions, push them, put them in writing, in sketches. Many schemes teeming with potential benefits have died in the heads or desks of the schemers because they are not brought out forcibly enough. Some may be too modest to bring their notions to those higher up while others become discouraged at the first belittling comment. Worst of all is the "main-strength" maintenance man who takes the attitude that he is not being paid to improve conditions and maintains that he is there simply to keep things running as they are.

Some of the trends in electrical practice that are most responsible for obsolescence in existing equipment may be summarized to advantage.

Trends in Electrical Practice

Synchronous motors have been so improved, particularly in starting characteristics, that they are now applied freely where but a few years ago induction motors were used. Synchronous motor control has also been improved in many ways among which are the prevention of stalling on undervoltage. Full advantage can be now taken of the power factor improving characteristics of synchronous motors together with their inherent adaptability to low speed drives.

Time-delay undervoltage relays on all large motors are helping to maintain continuity of service. They allow motors to coast through voltage dips of short duration and save wear and tear on the whole system which results from wholesale restarts after a momentary outage.

The wide and growing use of generator voltage (Ward Leonard) control for d.c. motors in the presence of a.c. supply has done much to reduce maintenance and increase production.

Among minor items are the more general use of indestructible one-piece winding for squirrel cage induction motors; improved bearings which have longer life and furnish better protection against the transfer of oil to the windings; and the general practice of extra bracing of coils to withstand the stresses of full voltage starting.

The practice of full voltage starting of motors has been extended to very large sizes.

Standard listed motors today are better protected from water, humidity, acid and alkali fumes, and abrasive dusts than were the "special" motors of a few years ago.

Lightning protection has been the subject of much study and progress in keeping with the efforts expended has been made.

Brakes and braking systems have changed for the better in many respects. Brakes themselves require much maintenance and are often the unsuspected cause of maintenance expense in motors and driven machines. A.c. solenoids are now hardly used; electric-hydraulic brake releasers are taking their place. Motor generators are furnishing d.c. to brake solenoids in many cases where a.c. solenoids were formerly used. Dynamic braking and regenerative braking are stopping thousands of shafts where formerly brake bands and wheels were being worn out.

Power factor improvements present one of the most fertile fields for inside investigation. Additions, transfers and substitution of units can be plotted graphically to determine the effective means for power factor improvements with little expense. By such procedure one may find ways to better electrical conditions within the plant and often advantage can be taken of the power factor clause in the power contract. Means for improving power factor are found in the use of high speed fully loaded induction motors, synchronous motors of unity or leading power factor, capacitors or synchronous condensers. Simple automatic means are available for holding a predetermined power factor in a plant through thick-and-thin.

If the broader spirit of scrutiny, which makes each unit prove its own merit, can be popularized, something worth while will have been accomplished. Therefore approach each unit in the plant as though it were a perfect stranger, imagine meeting it for the first time, look up its past record. Trade units around so that there will be fewer "square pegs in round holes." Make everyone miserable up the line until the wrong things are made right. Thus electrical maintenance men may be most instrumental in keeping the plant at least up to its present status with competitors.

We Have to Run Fast

While Lewis Carroll put a lot of nonsense in "Alice in Wonderland" and in "Through the Looking Glass," he forcefully brings to mind certain fundamental truths. Alice and the Black Queen had been running at top speed hand-in-hand for some time and then sat down under a tree to rest. Alice said, "I believe we are still just where we started from. In my country, when we run we get somewhere else." The Black Queen said: "In this country, we have to run as fast as ever we can to stay in the same place. If we want to get anywhere else, we have to run twice as fast as that."

Well, that is about the situation in industrial plants in this country, for only strenuous effort, long sustained, will hold a plant in a commanding position.

INDUSTRIAL ENGINEERING

L. C. MORROW, *Editor*

Vol. 88 AUGUST, 1930 No. 8

Sons of Ajax Go Afield

FOR most of us, summer thunderstorms are unavoidable annoyances that sometimes send shivers up and down our spines, interfere with golf games and fishing trips, and ruin our favorite radio programs. Nevertheless, there are two small groups of men, one in Michigan and the other in Ohio, who, if not defying the lightning as did Ajax of old, are now eagerly watching for the flashing bolts that annually cause serious losses of life and property.

These men have been sent out by the General Electric Company, in co-operation with other concerns, to study the vagaries of lightning and make on photographic films permanent records of the phenomena which they exhibit and produce. When nature fails to produce the raw material for their studies, artificial bolts will be made and hurled against selected transmission lines. Both groups of engineers are equipped with impulse lightning generators that will produce potentials of upwards of one and one-half millions of volts. Portable cathoderay oscillographs are employed to make the records that mean so much to the designers of protective and other equipment.

The problem of securing adequate protection from lightning has been a serious one since the first outdoor lines were put up, and has steadily grown in importance with the extension of electric service. However, the earlier process of designing protective equipment on the basis of what could be learned after a line had been struck, or equipment damaged by an induced charge, was much too slow and uncertain for modern needs; hence the field studies that are now under way.

Out of these studies will come better protection against interruptions of service and damage of equipment for every user of electrical energy.

What Will Control Be Like Tomorrow?

DIFFICULT it is to predict when the art of building controls and control boards will reach the stage when we can call it final. As soon as a certain design is completed, used for a time, and seems to be satisfactory—out comes a new design, a new development, a new application.

The heavy control board of yesterday gave way to the much lighter types of today. The old, massive masonry structure gave way to a compact and light metal-clad structure. The bellcranks of former days have been replaced by a small, push-button control. The present control board, with its heavy panels, circuit breakers, and whatnot, is likely in turn to be replaced by a number of small cabinets or metal-clad units smaller in size, occupying less floor space, and performing their work more efficiently, with less hazard to life, property, and the equipment controlled. They will be easier to operate, cheaper to maintain, and free from the necessity of constant care and supervision on the part of the maintenance engineers.

Truly, the development of new methods and devices for controlling electrical equipment is proceeding at a swift pace. Anyone who fails to recognize that fact and keep informed on what is going on is putting himself and his plant under a serious handicap. In every industrial plant the appropriation for modernization should contain a sizable sum for the replacement of all control devices that have been rendered obsolete by advances in the design and construction of such equipment.

We Repeat—Modernize, Rehabilitate, Now

DURING depression prepare for future production. A trite piece of advice, borne out nevertheless by common sense and by the experience of manufacturers during many cycles. There are several advantages of magnitude: opportunity to prepare without interrupting production; readily available labor; quick deliveries; favorable prices.

Industrial Engineering in its issue of February of this year told what to do in preparing for cheaper production. It told last month of specific modernization and rehabilitation programs being carried out. It also showed many illustrations of modern equipment at work, a feature being continued in this issue and the next.

But in the meantime the editors wanted to be assured that the average plant is doing things by way of getting ready for prosperity. So they sent a representative to visit a lot of plants in the Chicago territory, which is truly representative of industry. This man has reported in detail on fifty plants. His reports, summed up and averaged, say that in all of these plants the one department that is just as busy as usual, if not rushed, is the maintenance department. Our timeworn but sound advice is being followed. Plants are being put in order, equipment is being selected, some is being

ordered. Replacement and repair of equipment is going on. Buildings are being improved, some new ones are being erected.

It is gratifying to know that a campaign is bearing fruit—especially a campaign based on so sound a premise as was this of ours for modernization and rehabilitation. That accounts for only part of our gratification, however. The remainder is due to the fact that the equipment *selection* that is going on now is going to mean *orders* before many months. Everyone knows that there is nothing like orders to create other orders, and that the process once started grows of itself. Plenty of orders means plenty of employment, with the old industrial vehicle back on the main highway once again.

If there is a moral or a suggestion in this dissertation it is to the effect that anyone holding out on preparing now for future production had better get busy.

Praise We Norman Bel Geddes

(Who designed the plant of the Toledo Scale Company and associates shown on last month's cover)

WE presented last month's cover picture with much enthusiasm and some trepidation. The design for the new plant of the Toledo Scale Company is so different that we wondered if it might not be considered radical and we be accused of an impractical modernism.

Happily we succeeded in our aim of showing that the industrial plant, which of necessity must have utility value as a prime consideration, may also be beautiful. All comment concerning the cover picture indicates that it has been received with enthusiasm that equals our own.

Utility and beauty in combination were sought by the designer, Norman Bel Geddes, of New York. It is a combination about which Mr. Geddes is enthusiastic, and which he has secured in his designs of commercial products, such as the Toledo scale itself and the Simmons metal bed.

Norman Bel Geddes has been successful as a portrait painter (Caruso, Schumann-Heink, Whitlock, Galli-Curci), stage designer (*The Miracle* being one of many), advertising illustrator, manager of a firm of advertising illustrators, director of an advertising agency, and designer of furniture and other commercial articles. Apparently his personal preference of occupations favors the expression of his art in industry, which will be much to industry's advantage by way of both beauty and utility.

We said last month, "Modern equipment IS at work"—and we published forty pages of pictures under that title to prove it.

Then we promised additional pictures of modern equipment at work in this issue; they are here—eight of them.

Now we promise a third group in the September issue. Yes, modern equipment IS at work.

A New Nursery of Progress

PLACING the cornerstone of the new engineering laboratory of the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, Pa., without the help of a guiding hand was both an interesting feat and a significant symbol.

In its essence, the physical placing of the cornerstone was simple enough: Tiny beams of light from concealed sources played across a small model of the building and cornerstone on the speaker's stand, and were focussed on hidden photo-electric cells. As the model cornerstone was slowly lifted and put into place, the interruption of some of the light beams actuated a specially-designed crane that supported the real cornerstone.

With this simple demonstration of what modern science and engineering can accomplish, began the work of erecting an eleven-story building, a block long, that will cost with its equipment about $2,000,000. Among its many other features will be the distinction of being the largest and tallest building thus far erected by the arc-welding process.

Symbolic of the achievements of science in lightening the toil of human hands was the placing of the cornerstone of this nursery of progress. What secrets will come out of it, what developments and discoveries that will bless mankind, no one can foretell. The contributions of similar institutions have made life far easier and happier for us all during the past few decades, and are practically the cornerstone of our national prosperity. Many burdens, however, still remain to be lifted, many ills to be cured, and many desires to be satisfied by the more effective harnessing of forces which can be controlled only by a more precise knowledge of natural laws.

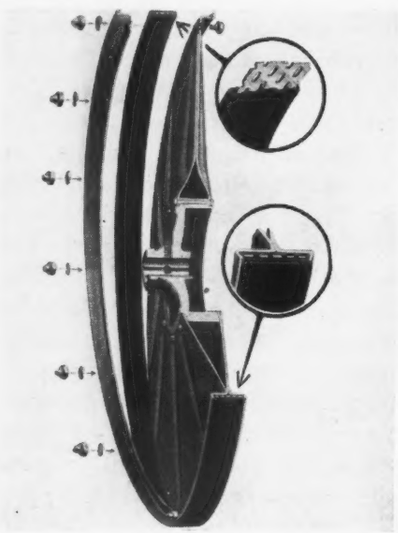
Few there are whose lives will not be touched at some point by the work of those who will labor in the sanctuary that is being erected for them by one of America's great industrial establishments. From this sanctuary may there come much that will lead to fuller lives and greater material well-being for all.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

Carter Quick-Change Tire for Bandsaws

A PATENTED quick-change bandsaw tire adaptable to any type of high-speed or low-speed bandsaw is now being made by the Carter Products Company, Grand Rapids, Mich. A flexible, endless steel, perforated core or backbone is the heart of the tire—the backbone being molded into the rubber tire during curing of the rubber in such a manner that there is the proper thickness of rubber on top, on bottom, and on both sides of the steel backbone band.



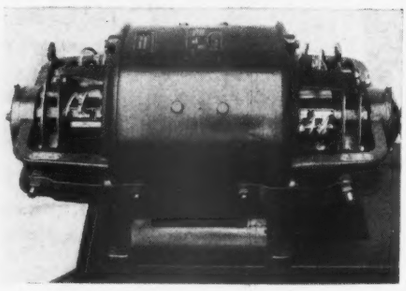
Perforations in the steel backbone permit the rubber, surrounding the backbone on all sides, to flow properly through the backbone.

Columbia Method for Changing Generator Voltage

COLUMBIA Electric Manufacturing Company, 1292 East 53rd St., Cleveland, Ohio, announces a simplified method of changing the voltage on the double, commutator-type Columbia electroplating generator.

This unit is now equipment with external connections that can be changed easily by taking off four nuts.

According to the manufacturer, this is radical departure in generator construction and really gives the advantages of two machines in one. In other words, the same generator can be used for both still-tank plating and barrel plating.

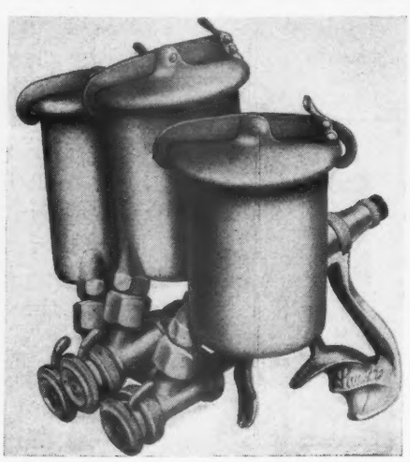


The illustration shows how the connections are made on the outside of the generators by means of heavy buses without the necessity of changing the line connections.

Paasche Multi-Color Airbrushes

AIRBRUSHES for applying 2, 3, or more colors at the same time, under the same control as with the standard model, have been introduced by the Paasche Airbrush Company, 1909 Diversey Parkway, Chicago, Ill. These units are known as the Paasche Universal Multiplehead Convertible Multi-color Airbrushes. Each color is controlled independently; thus all colors may be applied at the same time or shut off at will. Multipleheads in 40 different combinations are available.

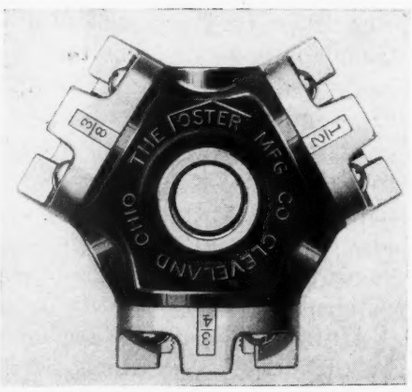
Units are made for use with 2, 3, or 4 colors and may be used as single units or expanded into gang units of any number of airbrushes, manually- or air-operated.



Overhead containers from 2- to 5-gal. capacity, and pressure feed tanks from 3- to 200-gal. capacity, equipped with a clamptight cover, may be used for high-speed production.

Oster-Williams Three-Way Threader

A THREE-WAY threader unit for ⅜-, ½-, and ¾-in. pipe that will put a standard length thread on a pipe as close as 4⅝ in. to the wall, has just been announced by The Oster Manufacturing Company, and The Williams Tool Corporation, Cleveland, Ohio.

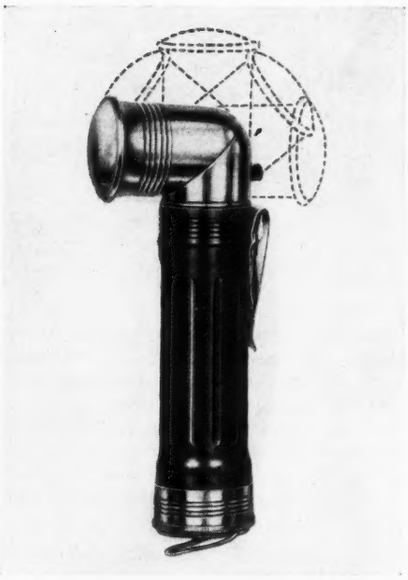


This threader, called the No. 000 "Chip Chaser," uses the same open-type die holders as the regular Chip Chasers, allowing a large area for oiling the chip clearance. The manufacturer states that the tool is very evenly balanced and cuts a perfect thread on any one of the three sizes.

The No. 000 is very small and light in weight and is equipped with a ¾-in. handle.

Burgess Revolving-Head Flashlight

A UNIQUE feature incorporated in a flashlight recently placed on the market by the Burgess Battery Company, Harris Trust Bldg., Chicago, Ill., is a 45-deg. revolving head which can



be turned at any desired angle for lighting up hard-to-get-at places. The device has a three-position safety switch and is equipped with a belt clip and a garter ring, giving the owner the use of both his hands. Two standard No. 2 Uni-cel batteries and a No. 14 Mazda lamp are used in this flashlight.

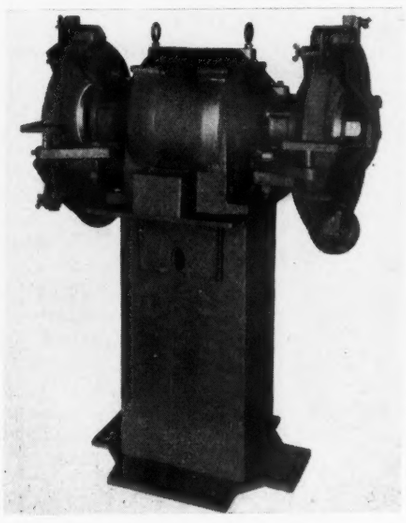
Production Grinders

A COMPLETE line of grinders and polishing lathes, marketed under the name "One Profit," is now being made by the Production Equipment Company, Cleveland, Ohio.

Steel replaces cast iron wherever possible. The bases are constructed from welded steel shapes. Fully inclosed motors are used, designed and built especially for grinder and buffer application. Unusually large spindles of nickel steel are carried in over-size ball bearings mounted in grit-proof housings.

Pushbutton-operated automatic starter provided with overload and no-voltage release assures complete motor protection. Starter is mounted in the base, the pushbutton in the cover convenient to the operator.

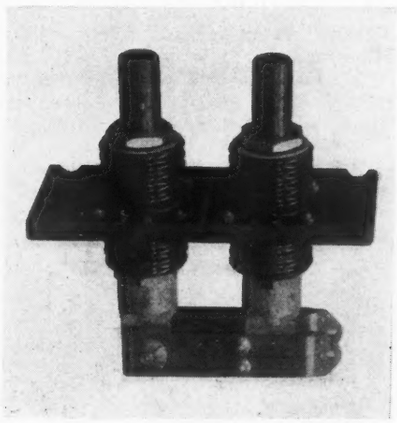
Units can be supplied in bench or pedestal types in sizes ranging from 1 hp. to 15 hp. for normal duty, heavy duty, or super-service requirements. The design embraces both motor-in-head and motor-in-base types.



Delta-Star Ventilated-Stud Disconnect Switches

DELTA-STAR Electric Company, 2400 Block, Fulton St., Chicago, Ill., has developed a high-capacity tongue-type, back-connected disconnecting switch.

A unique feature is the use of hollow studs with openings at both ends giving a free circulation of air throughout the entire length. There are no brazed or soldered joints. The cast base is made of high-strength bronze.

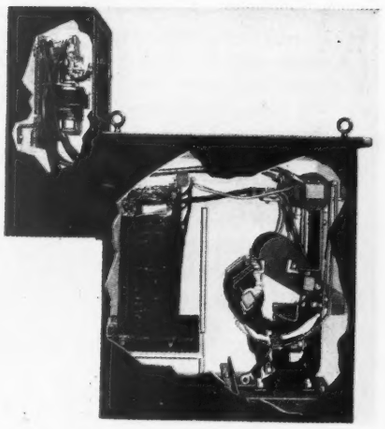


Electric Controller Full-Voltage Magnetic Starter

ANNOUNCEMENT of a 2,300-volt, full-voltage magnetic starter has been made by The Electric Controller & Manufacturing Company, Cleveland, Ohio, which is complete with overload relays and a self-contained potential transformer (to secure 220 volts for the control circuit). It is known as Type ZHS and is intended for across-the-line starting of squirrel-cage and synchronous motors, but may also be used to control the primary of slipring motors. The starter is built for reversing, non-reversing, and plugging applications.

The design of this starter is different from the switchboard, circuit-breaker type of starter commonly used in the past for full-voltage starting of high-voltage a.c. motors.

There are no ball cranks, toggle mechanisms or lever systems between the magnet armature and movable contact arm. The magnet armature, carrying the movable contact arm, is direct acting and is supported by only one large bearing pin and since the entire unit is totally oil-immersed, all working parts are always well lubricated and protected from dust and corrosion. This feature insures that the equipment is ready for operation at any time, whether it is out of service for a few minutes or for several months.

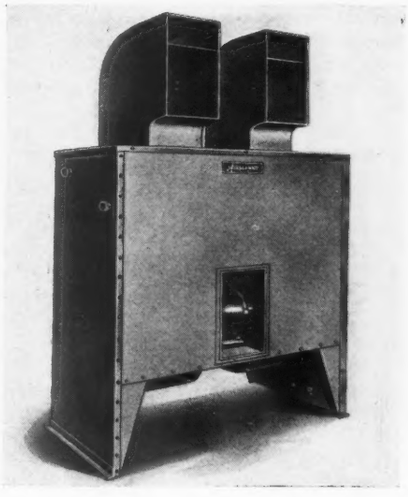


Contacts open and close the circuit with a wiping and rolling action, are duplicate and are easily renewable.

Skinner "Airblanket" Heating Method

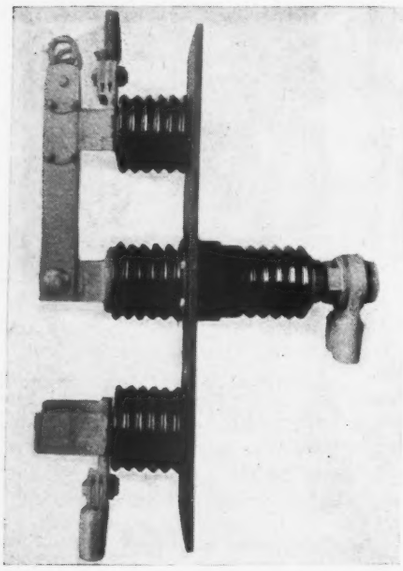
AN industrial-heating method designated "Airblanket," in which a blanket or ceiling of low-temperature, fast-moving air is projected horizontally over the breathing zone of a building for the purpose of holding the warm air issuing from a unit heater down in that zone, has been announced by the Skinner Brothers Manufacturing Company, Inc., 1400 S. Vandeventer Ave., St. Louis, Mo. This method, it is claimed, enables the warmed air to give off its warmth without the usual loss of heat incident to ordinary heating methods.

It employs specially designed unit heaters, of which a floor-type unit is shown.



Champion Transfer Switch

AN improved type of combination front and back connected selector or transfer switch for voltages up to 25 kv. has been developed by the

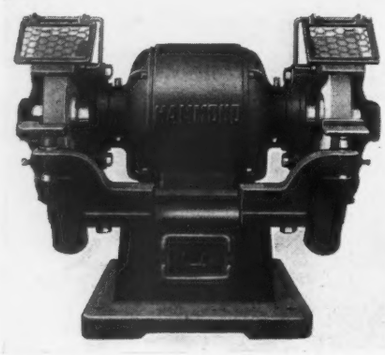


Champion Switch Company, Kenova, W. Va. This switch is of the double-blade type with safety locks and terminals for use with either flat or round conductors.

Hammond Type W Bench-Type Electric Grinder

THE Type W bench-type electric grinder manufactured by the Hammond Machinery Builders, Kalamazoo, Mich., is suitable for all general purpose work and for use as a light production grinder. It is made in 1½- and 2-hp. capacities, the motor being totally inclosed and designed for grinder service. Push-button control is conveniently mounted on the pedestal with a Cutler-Hammer automatic motor starter inside. This protects the motor from overload, low voltage, and phase failure.

The chrome-nickel steel shaft floats on over-size ball bearings protected by means of double labyrinth seals. Convenient oil cups, oil-level gages, and flushing plugs are regularly supplied.

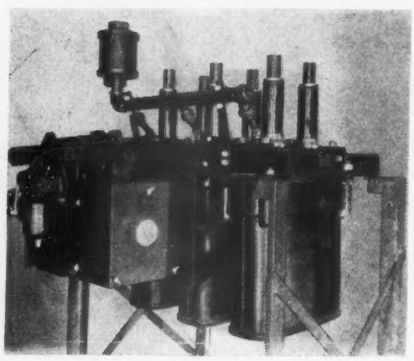


Standard equipment also includes universal, adjustable, steel wheel guards which can be adjusted to compensate for wear. Exhaust outlets, furnished as part of these guards, are for convenience in attaching to exhaust systems. Shatterless glass eye shields offer protection and convenience to the operator.

These machines are furnished for 110-, 220-, 440-, and 550-volt, one, two, or three phase, a.c., and for 110- and 220-volt d.c. service. They are supplied in both the bench and floor types. The 1½-hp. machine takes grinding wheels 10 in. in diameter by 1½ in. face, and the 2-hp. unit, 12 x 2-in. wheels.

Westinghouse Oil Circuit Breakers

A LINE of oil circuit breakers has been added to those manufactured by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. This line includes the Types B-7, B-8, B-9, and B-10 breakers which are rated at 15,000 volts and



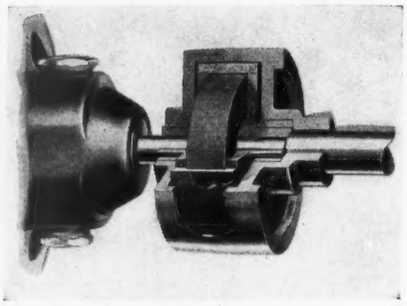
from 200 to 2,000 amp. These units have been designed for indoor service only and especially for use in power plants and substations where small space is available for switching equipment.

They are manually or electrically operated, and are available with one, three, or four poles, single throw. They are essentially for remote control form only and are designed for truck or structural frame mounting but readily applicable to cell mounting.

Washburn Shops "Lombard" Automatic Starter

ANNOUNCEMENT has been made by The Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass., of the development of the Lombard automatic starter for reducing starting load requirements and for absorbing shocks and vibrations. It is applicable to direct drives, gear, chain, V-belt, and flat belt drives.

In place of balls, weights, cams, and levers for obtaining pressure, an expanding centrifugal accelerator containing a fluid automatically gives the necessary pressure. The fluid is usually mercury for the smaller sizes and water for the larger sizes. There can be no leakage of the fluid as the accelerator is permanently sealed.



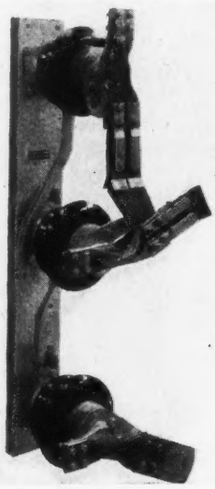
When the starter is at rest, the fluid is in the lower part of the accelerator. The fluid requires an interval of time before it becomes distributed uniformly around the inside of the accelerator, and until this distribution takes place, there is no effective pressure. It is this condition which allows the motor to attain full speed at once.

The accelerator is keyed to the motor shaft. It is totally inclosed and when once installed, requires no adjustment during its life. It will operate in either a horizontal or a vertical position, or in either direction.

Delta-Star Gang-Operated Switch

HEAVY-AMPERE capacity, double-throw, three-pole, gang-operated switches have been developed by the Delta-Star Electric Company, Chicago, Ill. In this model, known as "PMF Form 2," the characteristics of the original "PM Form 2" single-throw type with its ice-breaking toggle-blade motion has been retained.

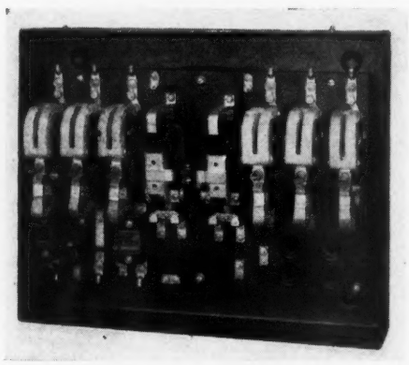
Gang operation from the center insulator insures that one side of the switch is open before the other side is closed.



General Electric Magnetic Reversing Switch

THE ability to control motors of greater horsepower than those controlled by the superseded type is the principal advantage of the inclosed, magnetic, reversing switch announced by the General Electric Company, Schenectady, N. Y. This switch, designated CR-7009-B-18, supersedes the CR-7009-B-5 unit of the same type.

The device is designed to throw small a.c. motors directly across the line. It consists of two triple-pole, mechanically-interlocked, magnetically-operated contactors with restricted-type blowouts, and with a normally-open interlock on each contactor. It also has two hand-rest temperature-overload relays. The contactors are mounted side by side on a molded base, instead



of back to back as in the previous design. The device is contained in a drawn-shell steel inclosing case.

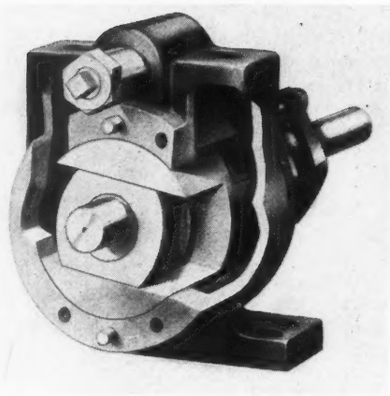
Maximum horsepower ratings of the improved switch are as follows:

Volts	3- and 2-phase, 3- or 4-wire	Single-phase
110	7½	3
220	15	7½
440	15	10
550	15	10
600	15	10

Globe Products "Rotapiston" Pump

ONLY four parts are used in the "Rotapiston" pump placed on the market by the Globe Products Company, Cleveland, Ohio. These moving parts are the cam-shaft, two pistons, and the revolving rotor in which they oscillate. Neither springs nor suction and discharge valves are required. The pump is therefore as simple as an ordinary rotary pump, but combines the high suction lift and discharge characteristic of the piston type, with the compactness of the rotary type. For this reason, and because it requires no priming, it is particularly adapted to uses where instant action and general reliability are essential.

Units are now manufactured in the following sizes: ½ gal., 1 gal., and 2 gal. per minute for each 100 revolutions



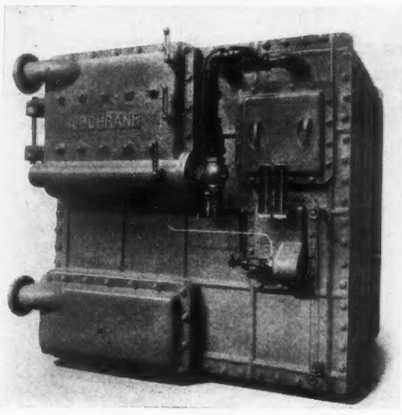
of the drive shaft. It is claimed that a suction lift of 18 ft. has been obtained.

The pump is normally set for clockwise rotation, but the direction can be readily reversed by merely changing the position of the relief valve. Three models of this pump are available; Nos. 1, 2 and 3, having pipe connections of ⅜, ¾, and 1 in., respectively.

Cochrane Deaerating Heater

TO eliminate corrosion in hot-water service and heating systems in office buildings, hotels, and industrial plants generally, the self-contained deaerator illustrated has been brought out by the Cochrane Corporation, Philadelphia, Pa. The process of eliminating the oxygen by use of the deaerator comprises the following steps; the water is heated to the temperature at which it boils under the total pressure of the atmosphere actually in contact with the water; the water is spread out by distribution over trays and is agitated for a time, thus increasing the area of the liberating surface from which gas may escape; the atmosphere in contact with the water is continually removed and replaced by pure steam to carry away the liberated gases.

The preheater which does most of the heating has eight passes, so that the water is circulated rapidly, advantageous from the standpoint of heat trans-



mission. The function of the evaporator is to supply sufficient vapor to ventilate or scavenge space surrounding the water flowing over the trays.

The shell of the deaerator is built for pressures varying from a complete vacuum up to 10 lb. gage, and standard deaerators are designed to receive water at 40 to 70 deg. F. and to deliver it at 150 to 180 deg. F. for any temperature up to 235 deg. Fahrenheit.

Wintroath Deep Well Turbine Pumps

WINTROATH PUMPS LTD., Alhambra, Calif., has recently announced a line of anti-friction bearing-equipped deep-well turbine pumps that have several interesting points. The line includes pumps of capacities ranging from 25 to 6,000 g.p.m. and ratings ranging from 3 to 400 hp. The standard pumps are directly driven by an

electric motor, but may be modified for belt drive by gasoline or oil engines. They can be used on either shallow wells, or those exceeding 500 ft. in depth, where the internal diameter of the well is 6 in. or over. In addition to lifting, they may be used as boosters against any desired pressure above ground.

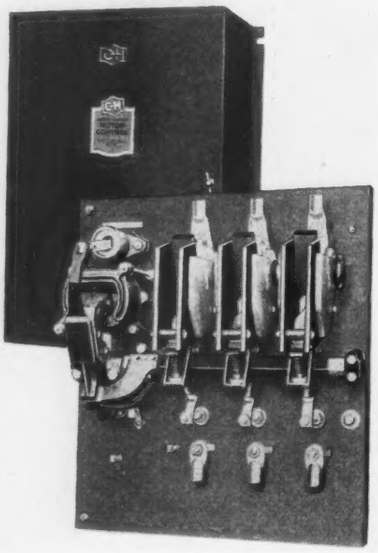
Construction is simple; the pump consisting of two main parts, the head and the impeller mechanism, or pump proper. The former consists of a cast-rotor, squirrel-cage, vertical-type induction motor, connected to the impeller mechanism by a sectionalized lineshaft. The motor is designed for across-the-line starting. The weight of the motor rotor, shaft, and impellers is carried by a Timken thrust bearing mounted on the lower end of the rotor shaft. Another anti-friction bearing is used as a guide bearing at the upper end of the shaft.

The head is connected to the pump by a lineshaft consisting of 10- or 20-ft. sections of Cumberland turned and ground shafting coupled together. A suction strainer is standard equipment. Suction pipe can be furnished in any desired lengths.

Cutler-Hammer Heavy-Duty A. C. Contactors

TWO magnetic contactors for heavy-duty a.c. service are announced by Cutler-Hammer, Incorporated, 150 12th St., Milwaukee, Wis. They are rated for maximum capacities of 300 to 600 amp. respectfully.

Features of these contractors make them generally applicable to all heavy-duty requirements. They are arranged for either two- or three-wire control, have continuous-duty operating coils and heavy, butt-type, solid-copper contacts. An air cushion absorbs the shock of the magnet on closing, thus reducing wear and making the contactor operate

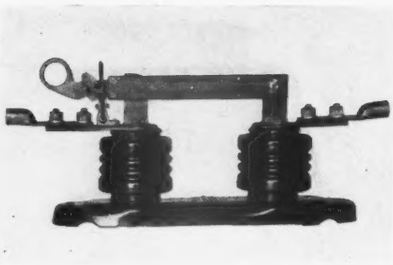


more quietly. For general use, the 300-amp. contactor is mounted in a wall-type inclosure, and the 600-amp. size is in a floor-type case.

General Electric Type LG-118B Indoor Disconnecting Switches

AN addition to its line of disconnecting switches has been announced by the General Electric Company, Schenectady, N. Y. These Type LG-118B switches are simple and compact in construction and are made single pole, single and double throw, front connected, back connected and combination front and back connected. The blade is made from hard drawn switch copper, and consists of two laminations.

They have non-corrodible hardware and phosphor-bronze spring washers which provide self-aligning contact pressure. The opening-eye of switches without blade latch is attached directly to the blade laminations, and is sufficiently large to permit ready insertion of a switchhook. The opening-eye of switches with blade latches is a casting, having a large opening and a cam on

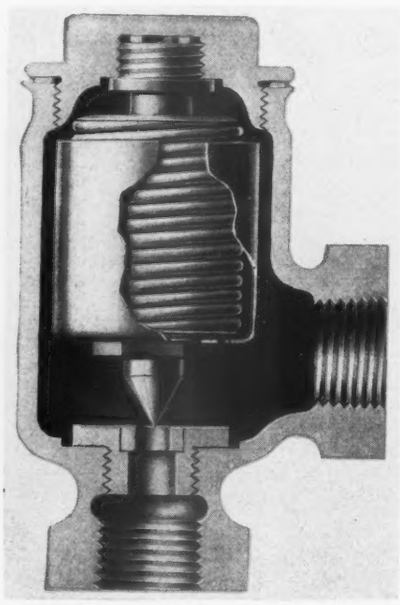


either side. One cam functions to release the latch, and the other operates in conjunction with the latch to provide a seal-break feature which starts the opening movement of the blade.

Insulators are of the moderate-duty, post-type, one-piece, wet-process porcelain, thoroughly vitrified and glazed a uniform chocolate color. The outer surface is corrugated to permit ample creepage distance. The cap has a double-crimped edge which is babbitted into a dove-tailed groove in the top of the porcelain shell. The pin and inner side of the porcelain shell are also corrugated at the area where they are cemented, to provide maximum grip. Base castings for 800- and 1,200-amp. switches with a back-connected stud are of a bronze alloy.

Sarco Improved Bellows-Type Trap

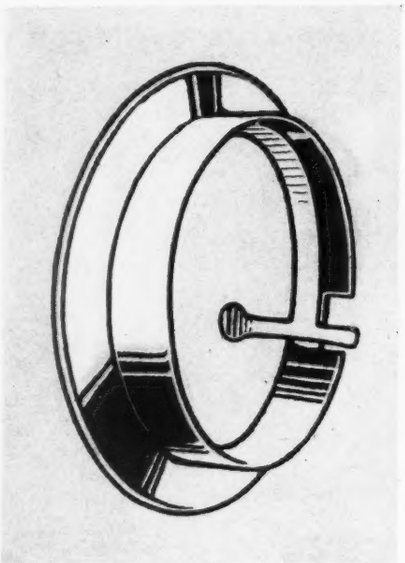
LONGER bellows, protective shielding, and a self-centering valve head constitute improvements made recently to the No. 9 steam trap put out by Sarco Company, Inc., 183 Madison Ave., New York, N. Y. Four corrugations have been added to the bellows' helical tubing, distributing the movement of the bellows over a total of fourteen corrugations.



The thermo-sensitive element is now incased by a heavy brass shield which protects it against damage by water hammer and impurities in the steam. Self centering of the valve has been accomplished by providing sufficient flexibility in the bellows to permit the valve head to move freely and center readily under pressure of the bellows. Valve head and seat are made of Monel metal.

Multiple "Lamplok"

THE Lamplok manufactured by the Multiple Selling Corporation, 350 Madison Ave., New York, is an insulated metal ring which slips over the threaded end of the lamp. The lamp is then screwed tightly into the socket.

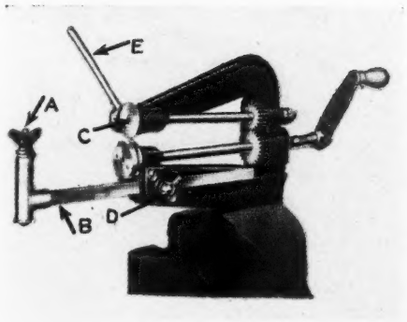


Once in place, the bulb cannot be removed except with a special pocket extracting tool furnished with every standard package. The device is guaranteed for 15 lamp replacements and fits any standard socket.

Allen Gasket Cutting Machine

DESIGNED to cut gaskets in sizes from 2 in. up, the gasket cutter illustrated, put out by the Allen Gasket Cutting Machine Company, 6 Hazard St., New Bedford, Mass., is adaptable to gaskets of irregular shape as well as to ring gaskets.

In cutting standard ring gaskets, a piece of sheet packing, larger than the outside diameter desired on the gasket, is punched in the center and clamped in position over center *A*. Then bar *B* is adjusted until the measurement indicating the desired diameter is even with the cutter *C*. The bar is then locked in position by screw *D*. Lever *E* is moved until the cutter *C* pierces the sheet, then the crank is turned clockwise and the



outside of the gasket is cut off. The operation is repeated on the inside cut.

For irregular-shaped gaskets, the outline is first marked on the sheet. Then the bar *B* is removed and the cutter used as shears.

Provision is made in the design for taking up any lost motion in the cutter shaft and for maintaining proper clearance between cutters.

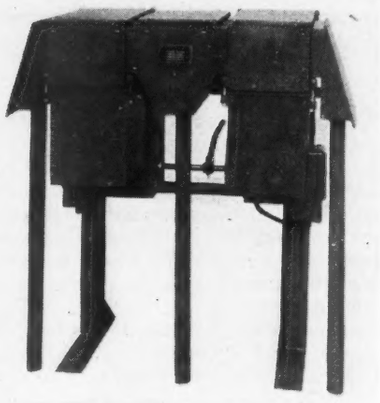
Diamond Chain Stock Drives

THE Diamond Chain & Manufacturing Company, Indianapolis, Ind., announces its stock drives, for all standard power applications, consisting of a roller chain and two sprockets, ready to be installed.

These items are carried in stock by distributors and supply houses in all leading centers in single to quadruple strands from ¼ to 75 hp.; in ratios up to 8.4:1, and for motor speeds up to 1,750 r.p.m. Diamond stock drives supplement the regular line of high-speed drives which handle up to 672 hp., and speeds up to 3,600 revolutions per minute.

Delta-Star Circuit Breakers

A LINE of metal-clad 7.5 kv. high-speed oil circuit breakers, known as Type "CIE," for controlling station auxiliaries has been developed by the Delta-Star Electric Company, Chicago, Ill. The three-pole elements are mounted in pairs, each being electrically interlocked

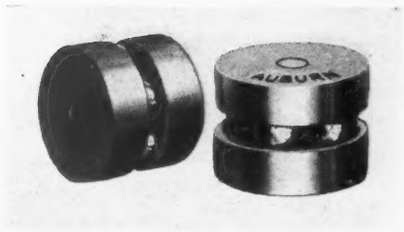


so that but one can be closed at a time, but either can be opened at will.

No live parts are exposed. The breakers are shipped in pairs ready for installation.

Auburn End-Thrust Ball Bearing

AN end-thrust bearing, known as the T-114, has been introduced by the Auburn Ball Bearing Company, 57-85 Clarissa St., Rochester, N. Y. The bearing fits in a recess at the end of the shaft, the recess being of the same diameter as the shaft.



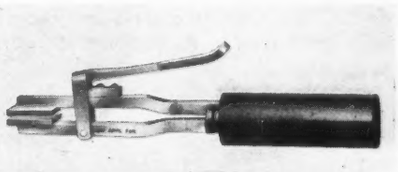
Because of the small pitch diameter of the ball groove and the large size of balls used, the peripheral speed of the balls is relatively low. The two races and balls are held together as a unit by a pin which is flanged at one end and makes a force fit at the other, permitting free rotation of the races yet holding them together.

Bearings are available in sizes from $1\frac{3}{16}$ to $3\frac{15}{16}$ in. in diameter.

Northwestern Wachs Metallic Electrode Holder

LIGHT weight and good balance are features of the Wachs metallic electrode holder, placed on the market by the Northwestern Manufacturing Company, Milwaukee, Wis. The handle is round, fits the hand, and is ventilated so that the holder can be used continuously without becoming uncomfortably warm. A wedge holds the cable securely in place.

In place of a spring, the Wachs holder makes use of a simple compression lever. This lever has a protective covering and is locked in place by a roller operating against a fixed ratchet. Both the roller and ratchet are made from hardened tool steel. The



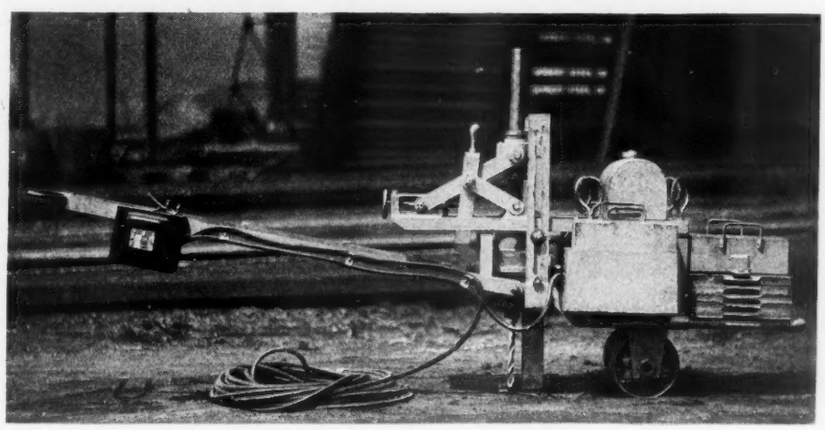
jaws are of copper and are welded in place. Gripping surfaces are smooth and are free from corrugations.

Two sizes are available. The first is for electrodes from 1/16- to ¼-in. in diameter inclusive, to carry currents up to 400 amp. The second is for electrodes ¼- to ½-in. in diameter inclusive, to handle currents between 400 and 800 amperes.

Guilbert "Toggle Bug" Drill

A PORTABLE drill, designated the "Toggle Bug," has been placed on the market by the Guilbert Steel Company, Pittsburgh, Pa. Other uses claimed for it besides drilling steel, stone, and wood are countersinking, grinding, sanding and polishing floors.

Without sectional and removable weights, it weighs about 440 lb. It has a capacity of 1½-in. holes or less at a bit speed of 380 r.p.m. Model D is for three-phase, 220/440-volt, 60-cycle service. The illustration below shows the unit in the operating position.



Borden "Beaver" Die Stocks

"BEAVER" four-poster die stocks in two models, No. 8 plain, and No. 8R ratchet, for threading from 1- to 2-in. pipe, have been announced by The Borden Company, Warren, Ohio. These units use a separate set of dies for each size of pipe.

Among the features claimed for

these units are: patented, self-contained rear end; a "man's-size" grip screw; grooved bolt and washer; open die slots for easy cleaning; safe, inclosed, die-retaining device; extra-heavy upright posts; reduction in weight and improved ratchet pawl.

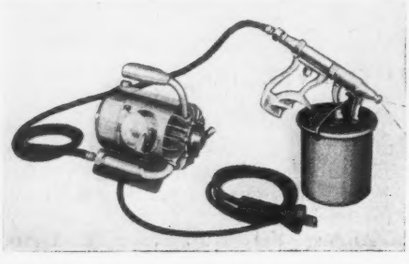
Whiteman & Barnes "Blue Diamond" High-Speed Drills

DIFFERENT design from the regular small high-speed drill and a special heat treatment are claimed to give "Blue Diamond" high-speed drills the ability to penetrate faster in steel forgings, cast iron, cold-rolled steel,

brass, bronze, aluminum, and alloyed metals. These drills are produced by Whiteman & Barnes, Inc., Detroit, Mich., and are claimed to reduce breakage, increase production, and lower tool cost. They are furnished in jobbers' sizes from $\frac{1}{16}$ to $\frac{1}{4}$ in. by 64ths and wire sizes from No. 1 to 55, inclusive.

Paasche Type LPAB Sprayer

AN air-coloring, air-shading, air-blending, and air-painting unit, designated Type LPAB Sprayer, has been placed on the market by the Paasche Airbrush Company, 1909 Diversey Parkway, Chicago, Ill. This round or fan sprayer is controlled by a light pistol grip and trigger action and will furnish from narrow to wide fan spray under low air pressure.

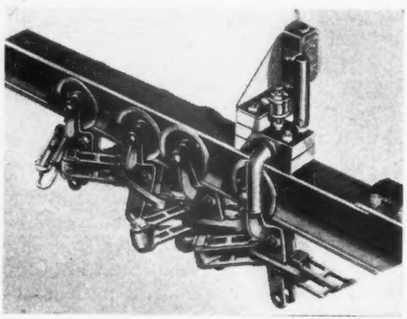


Taper-friction, color-control sleeve can be set to give whatever speed and spray size best suited for the work to be done. The universal motor-driven compressor is equipped with a specially designed silencer and air-cooled handle, and furnishes an even flow for light air brush and sprayer use. Complete equipment includes 10 ft. of electric cord and 12 ft. of 3/16-in. braided air hose with screw-tight couplings.

Kurth & Knapp Conveyor Safety Stop

A POSITIVE conveyor control that automatically stops the conveyor in the event of chain breakage has just been announced by the Kurth & Knapp Manufacturing Company, Detroit, Mich. The device may be equipped with a limit switch, automatically shutting off power to the conveyor drive, thus stopping the whole system when the conveyor chain breaks.

The automatic stop consists of a one-piece forged-steel crank composed of a guard arm and a lock arm inserted in



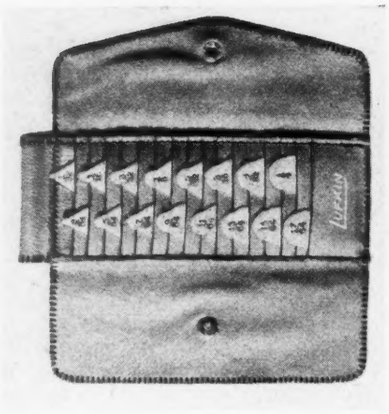
a bearing block which is bolted rigidly atop the monorail conveyor.

The guard arm oscillates over trolley wheels as they pass at normal speed. When struck by a runaway trolley wheel this guard arm is thrown upward against a stop block, forcing down the lock arm which catches and automatically stops the trolley wheel.

Lufkin Radius Gage

ADDITIONAL radius gage sets have been added to the line manufactured by the Lufkin Rule Company, Saginaw, Mich. These gages are now available in sizes up to ½ in. radius. Additional sizes are from $\frac{9}{32}$ to ½ in. radius by 32nds. Each gage is a separate unit. This permits it to be conveniently and accurately applied to the work. Internal and external forms are on the same piece.

The gages are regularly furnished in sets in leatherette folders in the following combinations: No. 77A, 16 gages from $\frac{1}{32}$ to $\frac{17}{64}$ in. by 64ths; No. 77B, 8 gages from $\frac{9}{32}$ to ½ in. by 32nds; No.



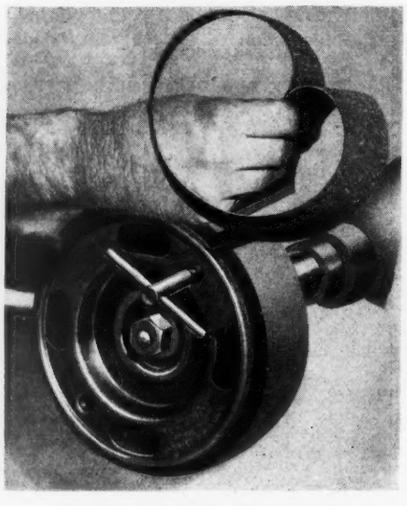
77C, 24 gages from $\frac{1}{32}$ to $\frac{17}{64}$ in. by 64ths, and $\frac{5}{32}$ to ½ in. by 32nds, and 77D, 16 gages by 32nds from $\frac{1}{32}$ to ½ inch.

Hunt Quick-As-Wink Buffing System

QUICK-AS-WINK cushion abrasive wheels announced by C. B. Hunt & Son, Salem, Ohio, are made in 6-, 8-, and 12-in. diameters and give a clean smooth buffing action the full width of the face of the wheel on either stationary or flexible-shaft buffers.

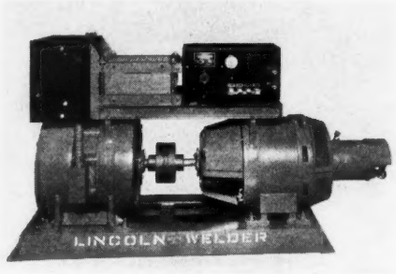
Abrasive cloth of any grade, from 24 to 180 grain, can be used, and the application of new band is done without removing the wheel from the spindle. Strips of abrasive cloth may be attached with or without metal end clips. A slight turn of the wrench tightens the strip on the wheel, and revolving the wheel causes a slight expansion of the rubber cushion so that the abrasive cloth hugs the entire surface.

The method of applying the abrasive cloth and the strength of construction permit safe operation at high speeds. Before shipment, it is stated, each wheel is tested at speeds up to 8,000 r.p.m. although speeds ranging from 3,500 to 5,000 r.p.m. are recommended as most efficient.



Lincoln Arc Welder

A WELDER with a rating of 600 amp. has recently been announced and placed on the market by The Lincoln Electric Company, Cleveland, Ohio.

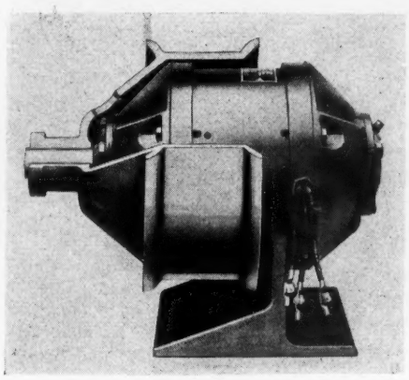


This unit was developed as a result of a demand for higher welding current to be used with large size metallic and carbon electrodes and also to supply current for the "Electronic Tornado," a process of automatic carbon arc welding. It may be had in either the portable truck type or stationary truck type. It is a motor-driven, single-operator, variable-voltage machine and has a current range of from 180 to 750 amp. The motor and generator are direct connected. The working mechanism of all controls are contained in a ventilated, inclosed steel cabinet with hand regulators and switches mounted on a panel which forms a side of the cabinet.

Reliance Motors for Runout Tables

SPECIAL motors, designated Type M, for runout tables in steel and tube mills and for other conveyor work, have been developed by the Reliance Electric & Engineering Company, Cleveland, Ohio.

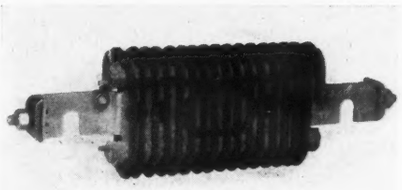
These motors are each provided with a single, heavy, welded-steel support so located that a pulley-type roller keyed to the motor shaft can rotate around the body of the motor. Various shaped rollers to suit the material to be conveyed can be used. The motors with rollers are lined up in tandem, the distance between being governed by the material conveyed. An installation may require any number of units depending on the distance of travel and the roller spacing.



These motors are fully inclosed, and are provided with class B insulation. Large ball bearings carry the motor rotor and load with an ample margin of safety.

General Electric Resistors

CONNECTIONS to rigid terminals are easily made with the edgewise-wound, heavy-duty resistor recently placed on the market by the General Electric Company, Schenectady, N. Y. This resistor, designated CR-9132, is of the unit-box type. Advantages listed by the manufacturer include unbreakable design, non-corrodible con-

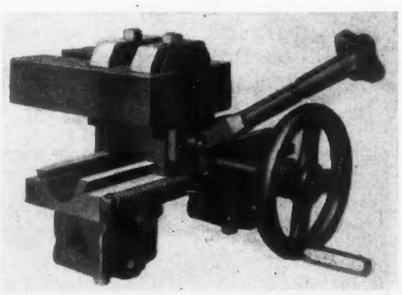


ductor, and maximum heat dissipation for minimum space consumption.

Units are offered in the form of a complete line of 20 sizes, covering a current range of from 22 to 136 amp., with a corresponding resistance range of from 2.5 to 0.058 ohms. Four combinations are standard, as follows: without taps; with a center tap; with two taps at 1/3 spacing, and three taps at ¼ spacing.

Ideal Commutator Grinder

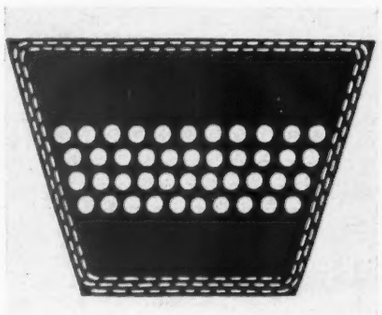
TO the line of commutator grinding and resurfacing equipment put out by the Ideal Commutator Dresser Company, Sycamore, Ill., has been added the "Ideal" grinder illustrated immediately above.



This grinder is designed so that it may be used within a space the same length as the base, there being no protruding parts on the side. The cross-feed wheel is in the back, making it possible to use the grinder on commutators having outboard fans or other obstructions.

Worthington Multi V-Drive

THE Worthington Pump & Machinery Corporation, Harrison, N. J., has recently placed on the market the Multi V-Drive developed in conjunction with the Goodyear Tire and Rubber Company.



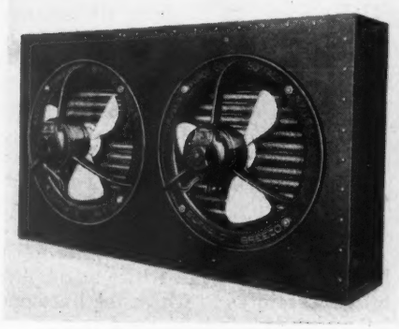
This drive consists of a number of endless molded V-belts running in V-grooved sheaves. It combines a rubberized cord V-belt, impervious to dust and moisture, with an improved V-grooved sheave.

Load-carrying members of the Goodyear Emerald Cord Belts used in the drive have high-grade cotton cords arranged in parallel lines and concentrated about the neutral axis. Each belt in the drive takes an equal share of the transmitted load.

Buffalo Forge Twin "Breezo-Fin" Unit Heater

THE Buffalo Forge Company, Buffalo, N. Y., announces a 16-in. twin "Breezo-Fin" unit heater with one set of steam and drip connections. When desired, one fan may be shut down thus lowering the steam consumption and reducing the temperature.

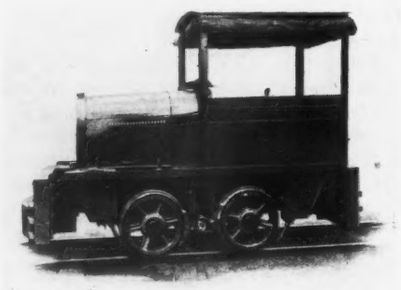
Overall dimensions, excluding motor, are 3 ft. 8½ in. x 10 in. x 2 ft. 5 in. with one-section, three-row Aerofin Coil, two three-blade 30-deg. angle, 16-in. Breezo wheels capacities according to the rating table are as follows: ⅛-hp. motor per fan at 1,440 r.p.m., 3,505 c.f.m.; 1/10-hp. motor per fan at 1,150 r.p.m., 2,800 c.f.m.; 1/20-hp. motor per fan at 860 r.p.m., 2,070 cubic feet per minute.



Brookville Ford-Powered Locomotives

THE Ford "AA" truck power plant is utilized for light locomotive haulage by two series of locomotives introduced by the Brookville Locomotive Company, Brookville, Pa., in 2-, 2½-, 3-, 3½-, and 4-ton sizes.

Maximum mobility and power is attained with a minimum of motor wear and effort by the use of a four-speed heavy-duty Ford transmission, in conjunction with a Brookville reverse drive, which device makes all four forward speeds available in either direction. In low gear, the motor, which develops 40 hp. at 2,200 r.p.m., is sufficiently powerful to slip all four drive wheels of a 4-ton locomotive, equipped with steel tires, operating on a dry sanded rail—and the steel tires are claimed to provide 25 per cent more traction than do ordinary chilled-face drivers. In high gear, this locomotive will attain a speed of 15 miles per hour.



The entire Ford power plant, including clutch and transmission, is used without alteration. Service is always available from Ford dealers.

Allen Soldering Oil

THIS oil is a product of the L. B. Allen Company, Inc., 6719-6733 Bryn Mawr Ave., Chicago, Ill. It is a concentrated soldering compound indorsed by the National Underwriters. It can be used for either hand or machine soldering.

Sullivan Machinery Distributors of "Tannergas"

TO obviate the freezing of air lines and tools as a result of moisture, as well as the frosting of tools during warm weather, a gas developed by C. H. Tanner is now being distributed by the Sullivan Machinery Company, Chicago, Ill. Designated "Tannergas," it is said to be harmless and non-explosive and to have a freezing point of 70 deg. below zero. Its function in a compressed-air system is to saturate the moisture in the lines so that it cannot freeze at the lowest temperatures to which the lines may be subjected. It is claimed that it will not wash off or affect the lubrication of pneumatic tools.

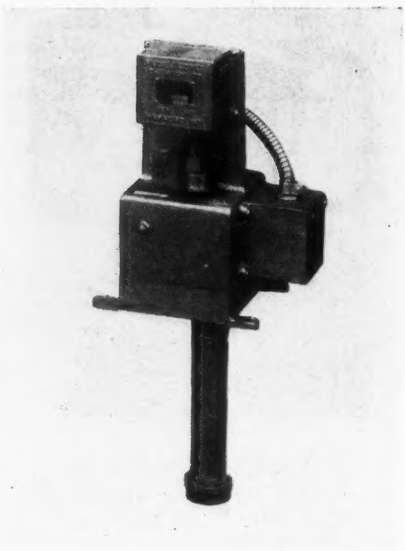
The system consists of a tank half filled with liquid and fitted with pipe connections and two valves. It is installed in existing compressed-air lines by removing a short section of the line.

Fusion "Weldite" Fillet Putty

COVERING of unsightly weld beads is the function of the "Weldite" fillet putty available from the Fusion Welding Corporation, 103rd Street and Torrence Ave., Chicago, Ill. This putty is used to give a smooth, neat appearing surface, hardens quickly, adheres tenaciously, and is not loosened by shock or exposure. It is applied over the weld bead before painting and becomes substantially as hard as iron, which is one of its constituents. It is packed in 12-lb. cans.

Paige & Jones Automatic Liquid Proportioner

AN electrical device which takes the place of the usual proportioning apparatus, such as tipping buckets, water motors, weirs and orifices, in lime and soda water softening has been introduced by the Paige & Jones Chemical Company, Hammond, Ind. Since no water or chemicals come in direct



contact with it, its accuracy is not affected by use. It is small, compact, and operates in oil, thus insuring long life.

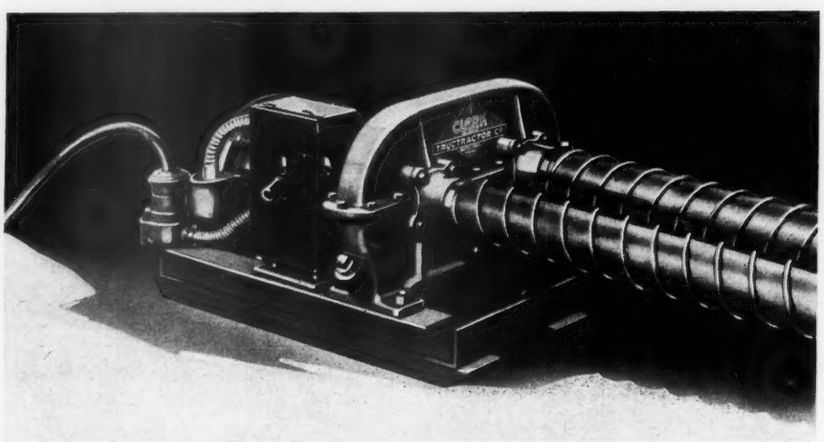
In operation the device receives electrical impulses from two contacts fitted to the head of a standard water meter. Variations in flow directly affect the number of impulses which are transferred by this device to the mechanical movement, thus controlling directly skimming pipes and other means of removing chemicals from the mix tank, which are then delivered by the usual means to the softener precipitation tank.

Clark Tructractor Twinveyor

A PORTABLE, flexible, power-driven elevating and tiering conveyor has just been introduced by the Clark Tructractor Company, Battle Creek, Mich. This equipment uses a unique principle—two external spiral tubes are turned toward each other by a power head. Anything placed on the conveyor travels forward rapidly.

A standard unit consists of six 8-ft. dual sections and a power head. Each section is light and joins to the assembly with an automatic lock. It is easily shifted about by one man and the entire 50-ft. line can be assembled or disassembled in six minutes, it is claimed. Flexibility is secured by the ability of any joint to take a 15-deg. angle horizontally or may be tilted 15 deg. up or 10 deg. down. In the elevating operation, sections of the tube may be supported by the material that has already been stacked.

An extension cord attached to the power head may be plugged into any power line.



Oxweld Oxygen and Acetylene Manifolds

IN order to furnish small users of oxygen and acetylene with an economical means of gas distribution, Oxweld Acetylene Company, 30 East 42nd Street, New York, N. Y., has introduced two small capacity manifolds, one of which is shown in the illustration. Where it is necessary to have a number of welding stations and the consumption of gases is not large enough to warrant the installation of an acetylene generator and a large oxygen manifold, these small manifolds will prove to be an effective means of having a piped supply of gases.

The six-cylinder oxygen manifold shown is of the wall type and has the duplex feature just as larger Oxweld manifolds have, so that three cylinders may be changed while the bank of three on the other side is maintaining the supply of oxygen.

The four-cylinder acetylene manifold is also of the wall type. Each cylinder lead has a valve in the header so that each cylinder is independent of the

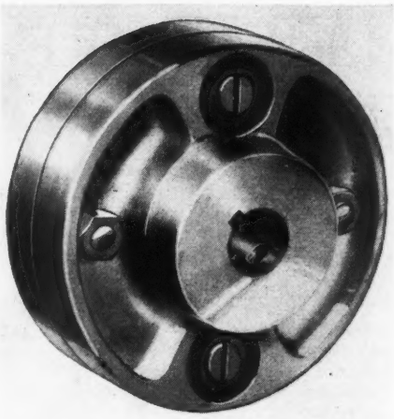
others. This makes it possible to use either one, two, three, or four cylinders at the same time so that a cylinder may be replaced without shutting off the acetylene supply.

Ajax Flexible Coupling

THE Ajax Flexible Coupling Company, Westfield, N. Y., has recently placed on the market a coupling called the Type "E." It is of the pin and rubber bushing class and is a modification of the standard Ajax Type "A."

This unit is in reality a special coupling of limited size, designed for purposes of economy on special applications such as centrifugal pumps, small speed reducers, fans, motor-generator sets, and in fact all jobs at motor speeds within the bore and load limitations of the coupling.

It is made with aluminum alloy flanges, hardened and ground alloy-steel drive studs, and specially com-



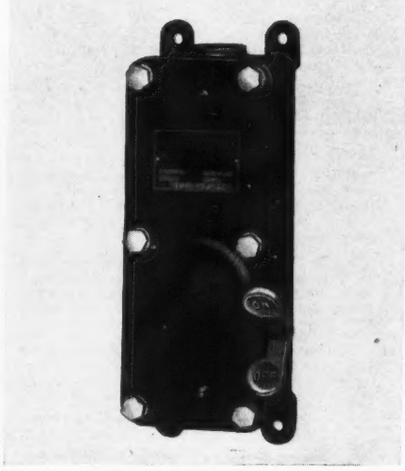
pounded rubber bushings firmly cemented to hard bronze bearings. Its weight is 2 pounds per coupling. The size is 4 in. outside diameter by $2\frac{1}{16}$ in. overall length.

Cutler-Hammer, Inc., Acquires Reynolite Division of Reynolds Spring

EFFECTIVE August 1, 1930, the Reynolite Division of the Reynolds Spring Company, Jackson, Mich., became the wholly-owned subsidiary of Cutler-Hammer, Inc. This transaction brought into the Cutler-Hammer line, according to the announcement, Reynolite products consisting of bakelite flush plates, plural plugs, and so on.

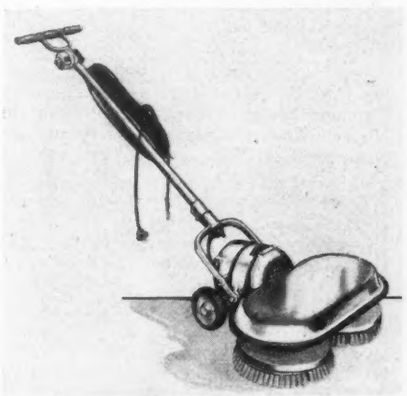
Industrial Controller Explosion-Proof Push-Button Station

AN explosion-proof, push-button station is announced by the Industrial Controller Division of the Square D Company, Milwaukee, Wis. This Class 9001, Type BR-10 control station is provided with a contact mechanism consisting of one normally open and one normally closed contact inclosed in a cast-iron housing with machined joints, and so constructed that it will withstand an internal explosion without injury to the inclosure and without transmitting the flame to surrounding gases.



Finnell Electric Floor-Scrubbing and Polishing Machines

ELECTRIC floor-scrubbing and polishing machines in three models have been introduced recently by Finnell System, Inc., Elkhart, Ind. Model 16F mounts a 15-in. diameter brush ring, driven at 175 r.p.m. by a ⅓-hp. General Electric waste-packed motor. This machine will operate freely in alleys having a width of 18 in., under furnishings having a 6- or 7-in. clearance from the floor, and flush up to baseboards. A 7-qt. water tank on the handle feeds scrubbing water to the floor surface



through the center of the brush ring.

Model 17F has an 18-in. diameter brush ring, driven by a ¾-hp. motor. The water tank is of 4-gal. capacity.

Model 80 is of the twin-disk type, and has two 10-in. diameter brush rings; it is driven by a ½-hp. motor. This machine scrubs a 21-in. path. Horizontal gear-driven brush rings and the adjustable-to-prone position of the handle permit operation of this machine for full length under machinery or other fixtures.

Jefferson Fuse Wrench

A FUSE wrench, for tightening and loosening the caps of ferrule-type renewable fuses is announced by Jefferson Electric Company, 1500 S. Laflin St., Chicago, Ill. It consists of a comfortably-sized, hard-wood handle with a hole in each end, both of which contain a hardened strip for engaging the slot in the fuse cap or plug.

In tightening or loosening the cap on a fuse simply insert one end of the fuse in the wrench and turn. The fuse fits snugly and the strip is held squarely in the slot.

Fuses of the 250-volt, 1- to 30-amp. size are provided for in one end, and 250 volt, 35 to 60 amp., and 600 volt, 1 to 30 amp. in the other.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog described, as given in these columns.

* * *

(207) BOX CAR LOADER—Two data sheets on heavy-duty box car loader.—Stephens-Adamson Manufacturing Company, Aurora, Ill.

(208) RECORDING INSTRUMENTS—Catalog Part 6. A complete list of recording instruments for the paper and pulp industry.—Taylor Instrument Companies, Rochester, N. Y.

(209) RESISTANCE UNITS—16-page reference catalog contains data of value to all engineers and designers in the radio and electrical equipment field.—Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, Ill.

(210) HERRINGBONE GEARS—Publication GEA-1201, illustrations and descriptions of Herringbone gears manufactured by this company in addition to many installation photographs.—General Electric Company, Schenectady, N. Y.

(211) CLEANING SYSTEM—"A New Tool For Industry"—Spencer Central Cleaning Systems.—The Spencer Turbine Company, Hartford, Conn.

(212) WIRING DEVICES—Catalog 30, 152 pages, loose-leaf form, complete information on several thousand catalog numbers.—The Bryant Electric Company, Bridgeport, Conn.

(213) HEATING SYSTEMS—24-page bulletin, "Controlling Heat and Heating Cost with the Airblanket."—Skinner Brothers Manufacturing Company, Inc., 1400 S. Vandeventer Ave., St. Louis, Mo.

(214) THERMOMETERS—Catalog 80, 28 pages, "Resistance Thermometers." Instruments for recording, controlling, and indicating temperatures. Space is devoted to heating and ventilating applications, refrigeration in chemical plants, and gas-making and other comparatively low temperature applications.—Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

(215) SPRAY PAINTING MACHINES—Catalog "'Less-Fog' Portable Air Painters," 24 pages of detailed descriptions and applications.—Gast Manufacturing Corporation, Bridgman, Mich.

(216) RUBBER—Catalog, "Ace Hard Rubber Protection for Chemical Process Industries."—The American Hard Rubber Company, 11 Mercer St., New York, N. Y.

(217) PAINT—Booklet "Master Specifications," concise information on the subject of iron and steel paint protection for the architect, engineer, and maintenance man.—Joseph Dixon Crucible Company, Jersey City, N. J.

(218) BUS GROUND RELAYS—Leaflet 20459, description of the construction, operation, and application of these units.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(219) GUY ANCHORS—Bulletin 803, data on Matthews Scrulix, Xpandix, and Traplox Anchors, both gray and malleable iron.—W. N. Matthews Corporation, 3722 Forest Park Blvd., St. Louis, Mo.

(220) TRACTORS—30-page illustrated booklet on the Monarch "35" tractor with a complete description including mechanical features and performance. The book contains approximately 50 photographs with several large cross sections in color.—Allis Chalmers Manufacturing Company, Milwaukee, Wis.

(221) RELAYS—Leaflet 20485, the N line of auxiliary relays for a.c. or d.c. circuits.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(222) WELDING ELECTRODES—Bulletin 6, "Yellow Jacket Weldite" electrodes for welding heavy sections of mild steel.—Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill.

(223) SWITCHES—Bulletin 39A standardized, outdoor, high-tension, "Unit Type," vertical-break and "MA-39" gang-operated switches.—Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill.

(224) HUMIDITY RECORDER—Bulletin 880, 8 pages, the L & N relative humidity recorder.—Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

(225) RUBBER—Bulletin, 24 pages, description of Linatex, a rubber for mining, engineering, and industrial uses.—Wilkinson Process Rubber Sales Corporation, 53 W. Jackson Blvd., Chicago, Ill.

(226) WELDING—40-page booklet, "Automatic Arc Welding by the Electronic Tornado Process" contains valuable information on automatic welding with the carbon arc, and results of tests of strength for ductility.—The Lincoln Electric Company, Coit Rd. and Kirby Ave., Cleveland, Ohio.

(227) PAINT—Bulletin "How to Paint Concrete and Masonry Surfaces," 16 pages of instructions for the selection and application of paint.—Medusa Portland Cement Company, 1002 Engineers Bldg., Cleveland, Ohio.

(228) CENTRIFUGAL PUMPS—Bulletin 215, double-suction, single-stage centrifugal pumps.—Pennsylvania Pump & Compressor Company, Easton, Pa.

(229) BATTERY CHARGERS—Leaflet 20478, "Rectigon Battery Chargers" construction and application details of these units in addition to operation data and a table showing the cost of operation.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(230) ROLLER BEARINGS — Booklet, "Timken Bearings in Rubber Mill Equipment," latest information covering mounting practices and general data concerning the application of tapered roller bearings in this industry.—The Timken Roller Bearing Company, Canton, Ohio.

(231) LIGHTING—Booklet, 33 pages, "The Way Out Of The Twilight Zone," a description of various types of lighting equipment and instructions for designing good systems of interior lighting in addition to tables showing present standards of foot candle illumination for commercial and industrial interiors, room and maintenance conditions to be considered, and outlet spacing and lamp size for commercial interiors.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(232) GEARS—Catalog 49, a complete list of Boston gear products in stock ready for immediate delivery.—Boston Gear Works Sales Company, North Quincy, Mass.

Coming Events

The Electric Hoist Manufacturers Association—Next meeting, September, 1930, Montour Falls, N. Y. Secretary, E. Donald Tolles, 165 Broadway, New York, N. Y.

American Welding Society—Annual Fall meeting, Congress Hotel, Chicago, Ill., September 22 to 26. W. M. Spraragen, 29 West 39th St., New York, N. Y.

American Gear Manufacturers Association—Fall meeting, Hotel Clifton, Niagara Falls, Sept. 29, 30, and Oct. 1. T. W. Owens, Secretary, 3608 Euclid Ave., Cleveland, Ohio.

National Safety Council—19th Annual Safety Congress, Sept. 29 to Oct. 4. Hotels William Penn and Fort Pitt, Pittsburgh, Pa.

Illuminating Engineering Society—Twenty-fourth annual convention, Hotel John Marshall, Richmond, Va., Oct. 7 to 10, 1930. Society headquarters, 29 West 39th St., New York, N. Y.

Ninth National Exposition of Power and Mechanical Engineering—Grand Central Palace, N. Y., Dec. 1 to 6, 1930. Managers, International Exposition Company.

Fifth Midwest Engineering and Power Exposition—Coliseum, Chicago, Feb. 10 to 13, 1931. Managers, Midwest Engineering Exposition, Inc., 308 West Washington St., Chicago, Ill.

National Fire Protection Association—35th annual meeting, Toronto, Can., May 11 to 17, 1931. Association headquarters, 60 Batterymarch St., Boston, Mass.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Motor Wiring Tables

Compiled by

A. L. ABBOTT

THESE tables have been compiled from the data contained in the National Electrical Code, Article 8, Section 808.

Voltage drops given in the tables are in each case computed for a total length of circuit of 100 ft. from panelboard to motor. This is the *single distance* and is not the total length of wire. The data includes resistance drop only and for a.c. motors does not take into account the reactance nor the skin effect, but is sufficiently accurate for ordinary purposes.

The size of a *fused switch* in a motor circuit is determined by the size of the fuses it must accommodate. The minimum allowable rated capacity of an *unfused switch* in a circuit is 115 percent of the full-load motor current.

SINGLE-PHASE A. C. MOTORS

Voltage	Hp.	Full load	Wire size Gage No. or circular mils			Conduit size for r. c. wire	Running protection		Max. rating branch circuit fuses	Voltage drop per 100 ft. (single distance) for r. c. wire
			Rubber covered	Varnished cambric	Slow-burning		Max. fuse rating	Max. setting time limit protective device		
		Amperes				Inches	Amperes	Amperes	Amperes	Percent
110	⅙	3.34	14	14	14	½	6*	4.25	15	1.6
	¼	4.8	14	14	14	½	8*	6.00	15	2.3
	½	7.0	14	14	14	½	10*	8.75	25	3.4
	¾	9.4	14	14	14	½	12*	11.75	30	4.5
	1	11.0	14	14	14	½	15*	13.75	35	5.3
	1½	15.2	12	12	14	½	20*	19.00	45	4.6
	2	20	10	12	12	¾	25*	25.0	60	3.8
	3	28	8	8	8	¾	35	35.0	90	3.3
	5	46	4	6	6	1¼	60	57.5	150	2.2
	7½	68	2	4	4	1¼	90	85.0	225	2.0
	10	86	0	2	2	1½	110	107.5	300	1.6
220	⅙	1.67	14	14	14	½	3*	2.25	15	0.4
	¼	2.4	14	14	14	½	4*	3.00	15	0.58
	½	3.5	14	14	14	½	6*	4.50	15	0.83
	¾	4.7	14	14	14	½	8*	6.0	15	1.1
	1	5.5	14	14	14	½	8*	7.0	20	1.3
	1½	7.6	14	14	14	½	10*	9.5	25	1.8
	2	10	14	14	14	½	15*	12.5	30	2.4
	3	14	12	14	14	½	20	17.5	45	2.1
	5	23	8	10	10	¾	30	29.0	80	1.4
	7½	34	6	6	8	1	45	42.5	110	1.3
	10	43	4	6	6	1¼	60	54.0	125	1.0
440	7½	17	10	12	12	¾	25	21.25	60	0.80
	10	21.5	8	10	10	¾	30	27.0	70	0.64

*Motors of 2 hp. or less may be protected by the branch circuit fuses only. N.E.C. 808-a, exception (1).

INDUSTRIAL ENGINEERING'S DATA SHEETS

Motor Wiring Tables

(*Continued from the preceding page*)

TWO-PHASE, SQUIRREL-CAGE INDUCTION MOTORS

Voltage	Hp.	Full load Amperes	Wire size Gage No. or circular mils			Conduit size	Running protection		Max. rating branch circuit fuses		Voltage drop per 100 ft. (single distance) r. c. wire Percent
			Rubber covered	Varnished cambric	Slow-burning	Inches	Max. fuse rating Amperes	Max. setting time limit protective device Amperes	Full voltage starting Amperes	Reduced voltage starting Amperes	
110	½	4.3	14	14	14	¾*	6	5.50	15	15	2.1
	¾	4.7	14	14	14	¾*	6	6.00	15	15	2.2
	1	5.7	14	14	14	¾*	8	7.25	20	15	2.7
	1½	7.7	14	14	14	¾*	10	9.75	25	20	3.7
	2	10.4	14	14	14	¾*	15	13.00	35	30	5.0
220	½	2.2	14	14	14	¾*	3**	2.75	15	.....	0.53
	¾	2.4	14	14	14	¾*	3**	3.00	15	.....	0.58
	1	2.9	14	14	14	¾*	4**	3.75	15	.....	0.70
	1½	4	14	14	14	¾*	6**	5.00	15	15	0.96
	2	5	14	14	14	¾*	8**	6.25	15	15	1.2
	3	8	14	14	14	¾*	10	10.00	25	20	1.9
	5	13	12	14	14	¾	20	16.25	40	35	2.0
	7½	19	10	12	12	1*	25	23.75	60	50	1.8
	10	24	8	10	10	1	30	30.00	80	60	1.4
	15	33	6	6	8	1¼	45	41.5	100	70	1.2
	20	45	4	6	6	1½	60	56.5	150	90	1.1
	25	55	4	4	6	1½	70	70.0	175	110	1.3
	30	67	2	4	4	1½	90	84.0	.....	150	1.0
	40	88	0	2	2	2	110	110.0	.....	200	0.82
	50	108	00	0	1	2½	150	135.0	.....	225	0.80
	60	129	000	00	0	2½	175	161	.....	300	0.76
	75	156	0000	000	0	2½	200	195	.....	350	0.73
	100	212	300,000	250,000	000	3	300	265	.....	450	0.70
	125	268	500,000	350,000	250,000	3½	350	335	.....	600	0.63
	150	311	500,000	400,000	300,000	3½	400	389	.....	622**	0.61
	200	415	800,000	600,000	500,000	4½	600	519	.....	830***	0.51
440	½	1.1	14	14	14	¾	2**	1.50	15	.....	0.13
	¾	1.2	14	14	14	¾*	2**	1.50	15	.....	0.14
	1	1.4	14	14	14	3*	2**	1.75	15	.....	0.17
	1½	2	14	14	14	¾*	3**	2.50	15	15	0.24
	2	3	14	14	14	¾*	4**	3.75	15	15	0.36
	3	4	14	14	14	¾*	6	5.00	15	15	0.48
	5	7	14	14	14	¾*	10	8.75	25	20	0.84
	7½	9	14	14	14	¾*	12	11.25	30	25	1.1
	10	12	14	14	14	¾*	15	15.00	40	30	1.4
	15	16	12	12	14	¾	20	20.00	50	40	1.2
	20	23	8	10	10	1	30	28.75	70	60	0.68
	25	28	8	8	8	1	35	35.00	90	70	0.83
	30	34	6	6	8	1¼	45	42.5	.....	70	0.64
	40	44	4	6	6	1¼	60	55.0	.....	90	0.52
	50	54	4	4	4	1½	70	67.5	.....	110	0.64
	60	65	3	4	4	1½	80	81.5	.....	150	0.61
	75	78	1	2	3	2	100	97.5	.....	175	0.46
	100	106	00	0	1	2½	150	132.5	.....	225	0.39
	125	134	000	00	0	2½	175	167.5	.....	300	0.49
	150	155	0000	000	0	2½	200	194	.....	350	0.36
	200	208	300,000	0000	000	3	250	260	.....	450	0.34

*Conduit one size smaller may be used under certain conditions. ½-in. conduit may be used for 4 No. 14s, N.E.C. 503-q.

**Motors of 2 hp. or less may be protected by the branch circuit fuses only. N.E.C. 808-a, exception (1).

***Circuit-breaker settings. Fuses not permitted. N.E.C. 805-l, 808-a, exception (5).